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CORIOLIS MASS FLOWMETER «EMIS-MASS 260»

USER MANUAL

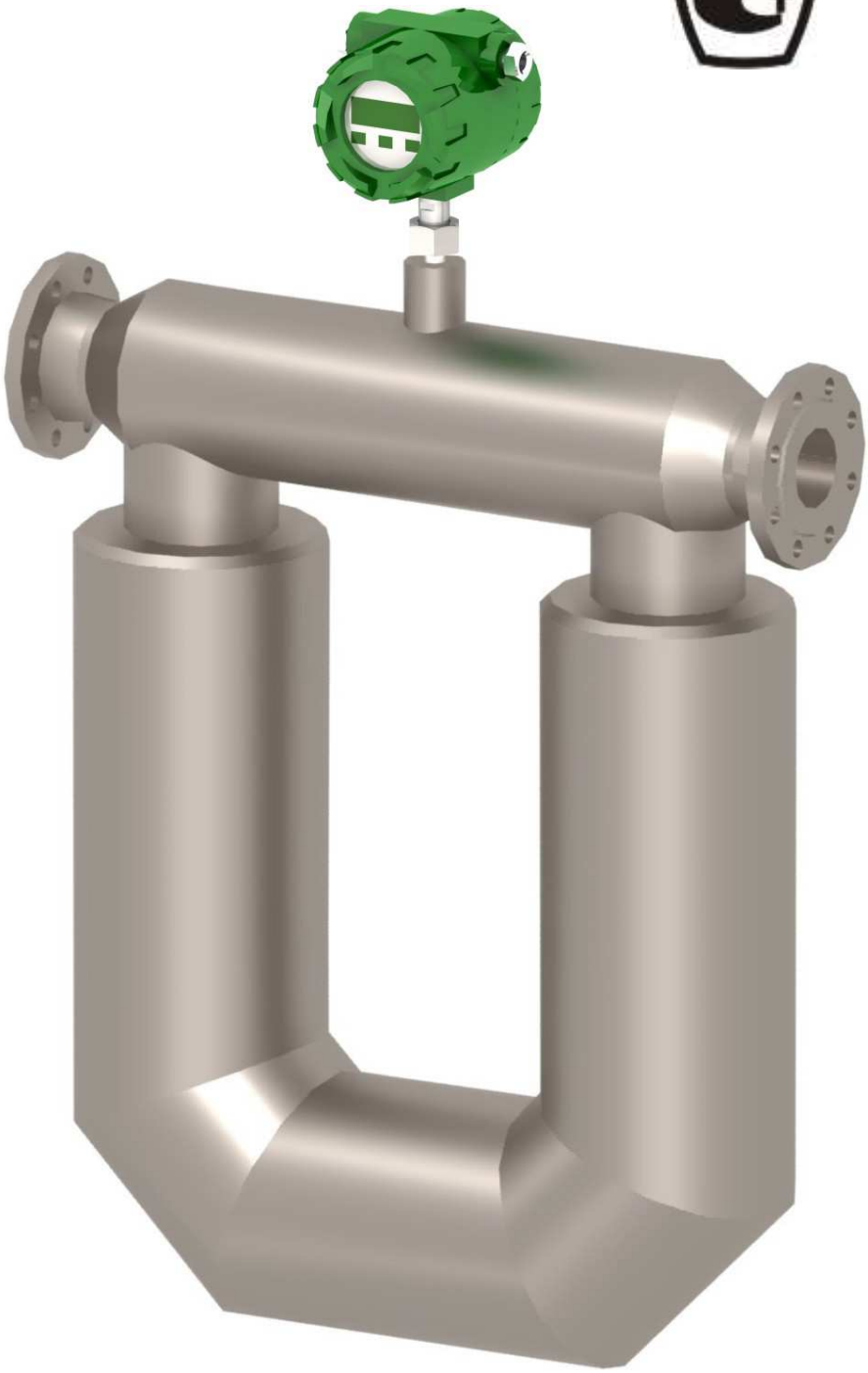
Direct mass measuring

High accuracy

Digital signal processing

Straight upsteam / downstream piping not required

High viscosity liquids measuring



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Russia, Chelyabinsk

General information

This user manual provides basic technical specifications, instructions for usage, storage and transportation, and other information necessary for the proper operation of the Coriolis Mass Flowmeters EMIS-MASS 260 (hereinafter - the "flowmeter" or "EM-260").

Modbus® is the abbreviation for Modicon Modbus Protocol and it is a registered trademark of Modicon, Inc.

ProLink® is a registered trademark of Micro Motion, Inc.

"EMIS", CJSC reserves the right to make changes in the design of the flowmeters, not deteriorated of their consumer characteristics, without prior notice. If you need additional information on the EMIS equipment, please contact your local dealer or the head office.

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CAUTION!

Before you start operating the flowmeter, you should carefully read this manual. Before starting the installation, use or maintenance of the flowmeters, make sure that you fully read and understood the contents of the manual. This condition is necessary to ensure safe operation and proper functioning of flowmeters.

For advice, contact your local dealer of "EMIS", CJSC or the support service:

Tel./ Fax: +7 (351) 729-99-12

e-mail: support@emis-kip.ru

CAUTION!

This manual applies only to the Coriolis Mass Flowmeters EMIS-MASS 260. This document does not cover other products of "EMIS", CJSC and the products of other companies.

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1 PRODUCT DESCRIPTION AND TECHNICAL DATA

1.1 Applications

The flowmeter is designed to measure the mass and volume flow, density, mass and volume of liquids, and use the gathered information for technological purposes or commercial accounting.

The flowmeter is used as the counter of gasoline, liquefied petroleum gas, kerosene, diesel fuel, oil, oil-water and other liquids in the chemical, petrochemical, oil, food, pharmaceutical and other industries and public municipal facilities.

The flowmeter is used in technological processes automatic monitoring and control systems in various industries, for stationary technological plants, land mobile refueling and pumping equipment, and in commercial accounting systems.

The flowmeter is designed for use in explosive safe and explosive environment. The flowmeter of explosion-proof modification "EMIS-MASS 260-Ex» has a combined type of protection "flameproof enclosure" complied with GOST R 51330.1, and the input and output "intrinsically safe" level «ib» complied with GOST R 51330.10.

CAUTION!
The flowmeter is not intended for use at nuclear facilities.

1.2 Principle of operation

The flowmeter consists of the following units (as shown in Figure 1.1):

- Flow sensor (1);
- Transmitter (2).

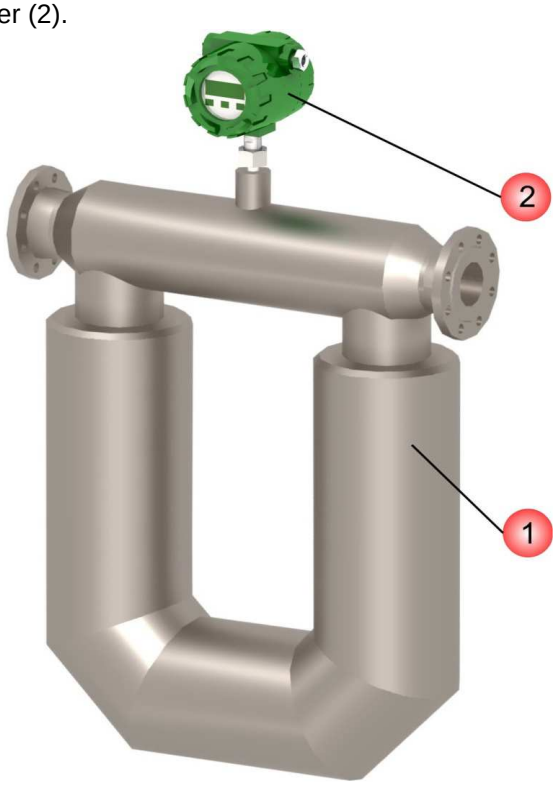


Figure 1.1 – Appearance of the flowmeter

Transmitter can be mounted right on the flow sensor (integral type) or separate from it (separate type).

The sensor is a measuring chamber with inlet and outlet flanges for mounting on a pipeline. Inside the measuring chamber there are two parallel U-shaped flow tubes, which vibrate by means of an electromagnetic coil and a magnet.

The principle of operation is based on the Coriolis effect.

Figure 1.2 shows the forces affecting the flow tube through which the measured liquid is flowing, during the half-cycle fluctuations, when the tube moves up.

At this time the liquid flowing into the tube creates resistance to its upward movement and downward pressure on the tube. Absorbing vertical momentum by driving around the tube's bend, the liquid, flowing out of the pipe, pushes the tube up. This makes the tube twist. When the tube is moving down in the second half of the oscillation cycle, it twists in the opposite direction. This twisting is called Coriolis effect.

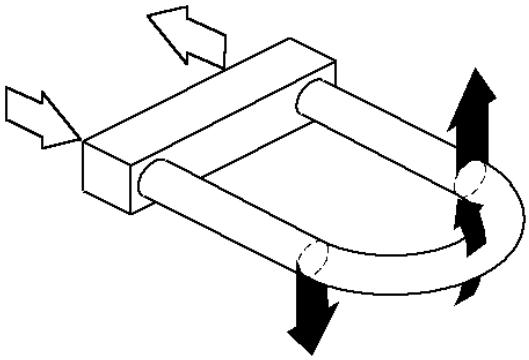


Figure 1.2 – Forces affecting the tube on the upward moving

Twist angle of the sensor tube is directly proportional to the amount of fluid passing through the tube within the certain time. Electromagnetic speed detectors situated on both inlet (left) and outlet (right) side of the tube, measure the tubes oscillations frequency. Mass flow rate is determined by measuring the time delay between the signals of those detectors. When there is no flow, the tubes don't twist and there is no time delay between left and right detectors signals. Mass flow rate **Q** is proportional to the time delay **Δt** between the detectors signals.

$$Q = K * \Delta t / 3.6 \text{ , kg/h} \qquad (1.0)$$

where K – calibration coefficient, g/s/μs;
Δt – time delay between the detectors signals, μs.

The density of the medium is determined by measuring the period of oscillation of the flow tubes, which is proportional to the density of the medium. The density measuring channel is calibrated for two different kind of medium with exactly known (measured by standard density meter) density (water and air). For each medium the flowmeters shows the flow tubes oscillation period corresponding to the medium density. The measured value of the oscillation period is shown in Menu item 70 (see the display menu). The medium density and the corresponding oscillation period for both water and air are entered in the menu display (Menu items 62 ... 65) or through Modbus. Due to the linear dependency of the oscillation period of the density the actual medium density can be determined by the oscillation period measured by the flowmeter.

Temperature measurement is performed using the built-in platinum temperature sensor Pt100. The measured temperature is used for automatic correction of the flow and density when the medium temperature changes. Temperature correction factors of flow and density are entered in the flowmeter memory at the factory and can be changed through the menu display or Modbus.

Flowmeters have the manual correction of flow when the medium pressure changes. When manual correction mode is enabled in the menu, the user should specify the actual pressure value taken from the external pressure sensor (see Menu items 39 ... 41).

The sensor generates the primary electrical signal containing information about the time delay between the signals of the detectors. The primary signal is transmitted to the electronic transmitter placed directly on the sensor or separate from it. The transmitter with digital signal processor processes the primary signal, calculates mass and volume flow values, temperature correction, generates output signals, and displays the information on the flowmeter's display.

Features of this measurement principle:

- direct measurement of mass flow rate in the pipeline without additional errors;
- maintaining high accuracy and stability over long time;
- ability to measure the flow of high viscosity liquids, non-Newtonian fluids, fluids containing solid or gas inclusions;
- reliable operation under conditions of vibration and misalignment of the pipeline, of the medium temperature and pressure changing;
- no moving parts inside the flowmeter (oscillation amplitude of the tubes is very small and they can be considered fixed) and parts subject to wear, which extends the life time of the flowmeter;
- no obstructions to the flow inside the flowmeter;
- ability to measure temperature and density of the liquid;
- no need for straight pipe sections before and after the flowmeter, as well as flow conditioning plates, etc.

1.3 Technical specifications

1.3.1 Technical parameters overview

Brief description of the technical specifications of the flowmeter is presented in Table 1.1.

Table 1.1 – Technical specifications

Parameter	Value
Nominal diameter, mm	10; 15; 25; 40; 50; 80; 100; 150; 200
Accuracy class	0.15; 0.25; 0.5
Gauge pressure	Up to 6.4 MPa Or up to 15 MPa (special order)
Medium temperature	-50…+350 ºC
Explosion proof grade (modification EMIS-MASS 260-Ex)	1Exd[ib]IICT6X (transmitter) 1ExibIIC(T1-T4)X (sensor)
Atmospheric pressure	84.0…106.7 kPa
Environment temperature	-40…+55 ºC or -50…+70 ºC (special order)
Relative humidity, %	90 ± 3 % (non-condensing, at 25 ºC)
Resistance to the external magnetic field	Up to 40 A/m, 50 Hz
Vibration resistance	class V1 according to GOST R 52931
Enclosure protection	IP65
Verification period	4 years
Temperature sensor	Pt100
Service life	not less than 12 years
Outline dimensions	See ***Приложение А***
Materials used	Sensor – stainless steel; Transmitter – aluminum alloy. Flowmeter does not contain precious metals.

Note:

1. It is possible to produce flowmeters with special characteristics according to the order.
2. Temperature range for OLED display is -40…+70 ºC.

1.3.2 Range of measurement

Flow ranges of the flowmeters with accuracy classes 0.15, 0.25 and 0.5 are shown in Table 1.2. Normal operation of the flowmeter guaranteed within the full flow range according to the Table 1.2.

Operation of the flowmeter with the flow rate exceeding the upper limit of the full flow range is not allowed.

The lower limit of the full measuring flow range depends on the parameters of the medium, and should be specified in the order.

Table 1.2 – Measuring mass and volumetric flow range for liquid

Nominal diameter DN, mm	Full flow range, kg/h (L/h)	Accuracy flow range, kg/h (L/h)		Zero stability, kg/h (L/h)
		0.15	0.25 and 0.5	
10	20 – 1 000	70 – 1000	50 – 1 000	0.1
15	40 – 2 000	150 – 2 000	100 – 2 000	0.2
25	120 – 6 000	400 – 6 000	300 – 6 000	0.6
40	600 – 30 000	2 000 – 30 000	1 500 – 30 000	3
50	1 000 – 50 000	3 500 – 50 000	2 500 – 50 000	5
80	2 400 – 120 000	8 000 – 120 000	6 000 – 120 000	12
100	4 000 – 200 000	15 000 – 200 000	10 000 – 200 000	20
150	10 000 – 500 000	35 000 – 500 000	25 000 – 500 000	50
200	20 000 – 1 000 000	70 000 – 1 000 000	50 000 – 1 000 000	100

The flow ranges are presented for water at temperature of 20…25 ºC, pressure of 0.1…0.2 MPa and density of 1,000 kg/m^3 under standard conditions. For liquids of different density the volumetric flow range should be calculated by dividing these flow range limits under standard conditions by actual density value.

If the measured flow rate is less than low flow cutoff value, the flowmeter will indicate zero flow and accumulation of mass and volume will pause. Low flow cutoff value is set to 1% of the maximum flow rate. Cutoff value can be changed through the menu display or through Modbus.

Flowmeter can measure flow over 1% of the upper limit of the full flow range but measurement error in the range of 1% to the lower limit of the full flow range (2%) is not standardized. However, this error can be estimated by the formula 1.1.

Medium density measurement range is 200…3000 kg/m^3.

1.3.3 Accuracy of measurement

Relative basic error of measurement of mass flow (mass) on pulse and digital output signals ($\boldsymbol{\delta_M}$) calculated as

$$\delta_M = \pm [\delta_0 + (Z / Q_M) *100\%], \quad (1.1)$$

where δ_0 – accuracy class, %;
Z – zero stability (according to Table 1.2), kg/h;
Q_M – measured mass flow rate, kg/h.

Note – For the accuracy flow range, corresponding to a given accuracy class (according to Table 1.2), the value of Z is assumed to be 0.

Absolute basic error of measurement of medium density ($\boldsymbol{\Delta\rho}$) is ± 1 kg/m^3.

Absolute basic error of measurement of medium temperature is ± 1 ℃.

Additional error of measurement of density, caused by a change of medium temperature is ±0.03 kg/m^3 for every 10 ºC of deviation from the density calibration temperature.

Additional error of measurement of density, caused by a change of pressure is ±0.015 kg/m^3 for every 100 kPa of deviation from the density calibration pressure.

Relative basic error of measurement of volumetric flow (volume) on pulse and digital output signals ($\boldsymbol{\delta_V}$) calculated as

$$\delta_V = \pm [\delta_0 + (\Delta\rho / \rho) *100\% + (Z / Q_V) *100\%], \quad (1.2)$$

where δ_0 – accuracy class, %;
$\Delta\rho$ – absolute basic error of measurement of medium density, kg/m^3;
ρ – measured medium density, kg/m^3;
Z – zero stability (according to Table 1.2), L/h;
Q_V – measured volumetric flow rate, L/h.

Note – For the accuracy flow range, corresponding to a given accuracy class (according to Table 1.2), the value of Z is assumed to be 0.

Relative basic error of measurement of mass flow (mass) on current output signal ($\boldsymbol{\delta_{IM}}$) calculated as

$$\delta_{IM} = \pm [|\delta_M| + 0.2*I_{max} / (4+16*Q_M / Q_{Mmax})], \quad (1.3)$$

where δ_M – Relative basic error of measurement of mass flow (mass), %;
I_{max} = 20 mA – maximum value of current output signal;
Q_M – measured mass flow rate, kg/h;
$Q_M$max – upper limit of the full mass flow range, kg/h.

Relative basic error of measurement of volumetric flow (volume) on current output signal ($\boldsymbol{\delta_{IV}}$) calculated as

$$\delta_{IV} = \pm [|\delta_V| + 0.2*I_{max} / (4+16*Q_V / Q_{Vmax})], \quad (1.4)$$

where δ_V – Relative basic error of measurement of volumetric flow (volume), %;
I_{max} = 20 mA – maximum value of current output signal;
Q_V – measured volumetric flow rate, L/h;
$Q_V$max – upper limit of the full volumetric flow range, L/h.

Additional error of measurement of mass (volumetric) flow rate, caused by a change of medium temperature is ±0.05 % of the maximum flow rate for every 10 ºC of deviation from the zero calibration temperature.

Additional error of measurement of mass (volumetric) flow rate, caused by a change of pressure is ±0.02 % of the maximum flow rate for every 100 kPa of deviation from the zero calibration pressure.

The effect of changes in temperature and pressure can be adjusted by zero calibration under the actual pressure and temperature (see paragraph 2.5.4 Zero point adjustment").

1.3.4 Power supply

Electrical power of the flowmeters, depending on its voltage modification is provided by an external DC 24V power supply or AC 220 V with frequency (50 ± 1) Hz.

Parameters of the power supply are presented in Table 1.3.

Table 1.3 – Power supply parameters

Nominal voltage	Voltage range	Maximum power consumption
DC 24 V	18…30 V	15 VA
AC 220 V	187…242 V	15 VA

1.3.5 Output signals

The flowmeter has the following output signals:

- pulse output;
- current output;
- digital output (RS-485 interface).

To display the values of the mass flow, volume flow and other measured parameters the flowmeter's transmitter has built-in display.

1.3.5.1 Pulse output

Pulse output signal is a periodical pulse signal with the frequency which is proportional to the measured value of the mass flow rate considering the damping time specified in the menu 49.

The pulse output can be configured to denote mass flow rate, volumetric flow rate or density of the medium. Pulse output is active.

The total number of pulses generated on the pulse output corresponds to the mass or volume of the fluid passing through the flowmeter since the measurement start.

Maximum frequency (fmax) of the pulse output signal calculated as

$$fmax = Qmax / (3.6*m), Hz \quad (1.5)$$

where Qmax – upper limit of the full mass flow range, kg/h;

m – pulse weight, g/pulse.

Pulse output signal frequency range is 0…10000 Hz. Maximum frequency can be increased up to 12000 Hz.

The amplitude of the pulse output signal is 13 V.

Default pulse weight is presented in Table 1.4.

Table 1.4 – Default pulse weight

DN, mm	10	15	25	40	50	80	100	150	200
Pulse weight, g/pulse	0.05	0.1	0.4	2	4	8	10	20	40

1.3.5.2 Current output

The value of the current in the current output circuit ranges from 4 to 20 mA and is proportional to the measured flow rate.

The current value of 4 mA corresponds to zero flow rate. The current value of 20 mA corresponds to the upper limit of the full flow range of the flowmeter (Qmax).

The current output can be configured to denote mass flow rate, volumetric flow or density of the medium.

Current output is active.

The current signal parameters are presented in Table 1.5.

Table 1.5 – Current output signal parameters

Current output signal	
Current value	4…20 mA
Load resistance	250…600 Ohm

1.3.5.3 Digital output

Digital interface complies with the requirements EIA/TIA-422-B and recommendations ITU V.11 and provides the opportunity of networking and transferring of all measured parameters. The digital interface specifications are presented in Table 1.6.

Table 1.6 – Digital interface specifications

Digital interface	
Standard	EIA RS-485
Data transfer protocol	Modbus RTU
Data transfer baud rate	1200, 2400, 4800, 9600 bit/s
Maximum distance	300 m
Data format	8 data bits, 1 start bit, no parity bit, 2 stop bits (default).

Data format can be changed in the menus 30, 31.

The following measured parameters can be transmitted through the digital interface: mass (volume) flow rate, mass (volume), density and temperature of the medium.

Digital interface can also be used to calibrate and to configure the flowmeter.

Flowmeter supports two versions of the Modbus register map:

- «EMIS» register map version 2.xx is supported by the «EMIS-Integrator» software and set as default at factory;
- «ProLink» register map version 3.xx compatible with ProLink II software.

Register map and description for «EMIS» version 2.xx are presented in the **Appendix D**, for «ProLink» version 3.xx – in the **Appendix E**.

Register map version switching can be performed by the «EMIS-Integrator» or changing the value of the corresponding Modbus register (see **Appendix D**) using third party serial port tools.

1.3.6 Display

The flowmeter's OLED graphic display contains 4 lines with 16 symbols per line. The following measured parameters can be displayed:

- Mass flow rate;
- Volumetric flow rate;
- Medium density;
- Medium temperature;
- Total mass;
- Total volume.

Display operation is provided by the means of three optical sensor buttons below the display. Display operation described in the paragraph 2.5.3 Display operating".

1.4 Pressure drop

The pressure drop on the flowmeter (ΔP) at maximum flow rate, pressure and temperature is not more than 0.13 MPa for water medium.

In the process of measurement flow of liquids it is necessary to consider the cavitation effect (liquid boiling), which may occur in certain conditions of the flow. Cavitation may cause the flowmeter work abnormally. To prevent this, it is necessary to keep the certain pressure at the distance of 5*DN after the flowmeter. That pressure must be not less than critical pressure (Pcr) calculated as

$$Pcr = 2.9\ \Delta P + 1.3\ p_V,\ \text{kPa} \qquad (1.6)$$

where ΔP – pressure drop on the flowmeter, kPa;

p_V – saturated steam pressure at working conditions (background information), kPa.

If the pressure calculated by this formula exceeds the actual pressure in the pipeline, a safety valve should be installed to increase the pressure.

1.5 Explosion protection

The flowmeters of explosion-proof modification "EMIS-MASS 260-Ex» have a combined type of protection "flameproof enclosure" complied with GOST R 51330.1, and the input and output "intrinsically safe" level «ib» complied with GOST R 51330.10. The sensor explosion proof grade is showed in Table 1.7.

Table 1.7 – Sensor explosion proof grade

Temperature code	Explosion proof grade
“100”	1Ex ibIICT4X
“200”	1Ex ibIICT3X
“350”	1Ex ibIICT1X

Transmitter explosion proof grade is 1Exd[ib]IICT6X.

Explosion proof grade is written on the name plates attached to the body of the sensor of explosion-proof modification and to the transmitter.

The name plates’ appearance is showed in the paragraph 1.6 Name plates”.

The "X" letter in the explosion proof grade means the special requirements:

- the measured medium temperature must not exceed the maximum temperature according to the explosion proof grade temperature group;

- explosion protection is provided under pressure not exceeding the maximum allowable pressure for the given modification;

- connection of external circuits to the flowmeter must be implemented through the cable entries complied with GOST R 51330.1;

- unused cable entry must be closed with the end cap supplied by the flowmeter’s manufacturer or other end cap complied with GOST R 51330.1;

- connection of the external devices to the pulse, current and digital outputs of the flowmeters of “Ex” modification must be implemented in accordance with GOST R 51330.1.

Explosion protection type of "flameproof enclosure" is implemented by putting the electrical parts of the flowmeter into the flameproof enclosure in accordance with GOST R 51330.1, which prevents the explosion from coming out of the flowmeter into the explosive environment.

Explosion protection of the enclosure is ensured by the following means:

– the shell withstands the explosion test at the test pressure of 4 times the pressure of the explosion;

– axial thread length and number of full turns of thread engagement comply with GOST R 51330.1 requirements;

– the gaps and lengths of flat and cylindrical flameproof joints comply with GOST R 51330.1 requirements;

– maximum flowmeter’s surface temperature in working conditions must not exceed the temperature range in accordance to GOST R 51330.0 for the temperature groups:

- T4 for the flowmeters with temperature modification code «100»;

- T3 for the flowmeters with temperature modification code «200»;

- T1 for the flowmeters with temperature modification code «350».

Explosion protection type of input and output "intrinsically safe" circuit level «ib» is ensured by the following means:

– external power supply and connection of the external devices to the pulse, current and digital outputs of the flowmeters of “Ex” modification must be implemented in accordance with GOST R 51330.1;

– electric load of anti-spark circuit elements of the flowmeter does not exceed 2/3 of their certified values;

– the values of parameters of the left/right signal coils, drive coil and the temperature sensor circuits do not exceed the limits in accordance with GOST R 51330.10;

– spark safety barrier with Zener diodes is applied;

– electrical clearances and creepage distances comply with GOST R 51330.10. Insulation resistance between the sensor outer shell and electrical circuits elements can withstand the testing voltage of 500 V AC rms;

– internal capacity and inductance of the circuit do not accumulate energy, dangerous for spark ignition gas mixtures of category IIC;

– current-conducting elements and electronic components of the flowmeter circuit are protected from the environment influence with the shell, which provides the protection degree IP 65 according to GOST 14254.

Block diagram of the flowmeter is shown in Figure 1.3.

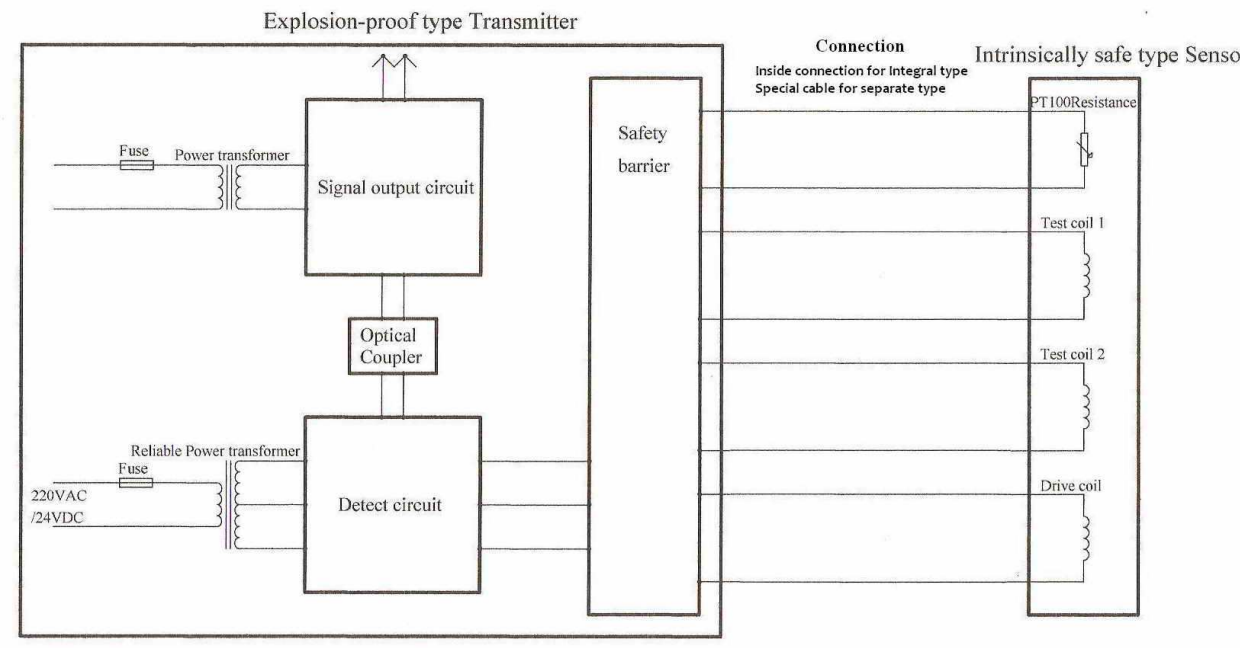


Figure 1.3 – Block diagram of the flowmeter

Input and output parameters of intrinsically safe circuits are shown in Tables 1.8 and 1.9.

Table 1.8 – Input parameters of intrinsically safe circuits

Parameter name	Parameter value		
	Left / right signal coils	Drive coil	Temperature sensor
Maximum input voltage Ui, V	5.4	10.5	5.4
Maximum input current Ii, mA	72	70	72
Maximum input capacity Ci, pF	50	50	50
Maximum input inductance Li, mH	2.2	3.5	0.010
Maximum input power Pi, W	0.097	0.184	0.097

Table 1.9 - Output parameters of intrinsically safe circuits

Parameter name	Parameter value for the circuit of		
	Left / right coil power	Drive coil power	Temperature sensor power
Maximum output voltage Uo, V	5.4	10.5	5.4
Maximum output current Io, mA	72	70	72
Maximum output capacity Co, µF	10	1	10
Maximum output inductance Lo, mH	5	4.5	5
Maximum output power Po, W	0.097	0.184	0.097

Parameters of the sensor coil windings are shown in Table 1.10.

Table 1.10 – Coil windings parameters

Coil	Wire diameter, mm	Number of turns	Resistance, Ohm
Left / right signal coils	0.13	500	20 ± 0.5
Drive coil (DN10 – DN40)	0.13	300	11 ± 0.5
Drive coil (DN50 – DN200)	0.27	300	8 ± 0.5

Maximum length of the connection cable for the separate type flowmeter is 300 m.

Drive coil power circuits are electrically isolated from other circuits by means of the undamaged transformer according to GOST R 51330.10. Insulation between primary and secondary windings can withstand voltage of at least 1.5 kV.

Ambient temperature for the flowmeters of “Ex” modification must be between -20 and +40 ºC.

1.6 Name plates

Flowmeter's parameters are marked on the name plates attached to the top side of the transmitter and to the body of the sensor. Flowmeter has the following name plates:

1. Main name plate with technical parameters
2. Sensor name plate with sensor explosion proof information.

The main name plate is produced according to Figure 1.4 and contains data presented in Table 1.11.

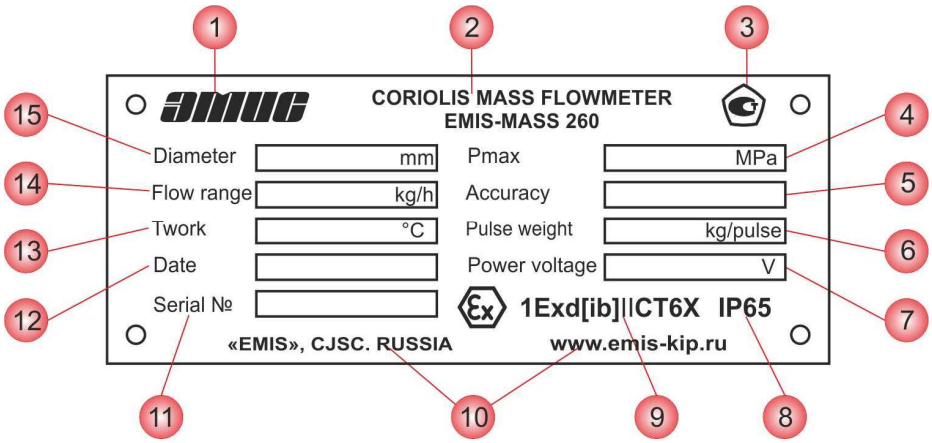


Figure 1.4 – Main name plate

Table 1.11 – Main name plate data

Item №	Description
1	Trademark of the manufacturer
2	Flowmeter name
3	Measuring approval sign
4	Maximum allowable pressure (Pmax)
5	Accuracy class
6	Pulse weight
7	Power supply voltage
8	IP protection grade
9	Explosion protection grade and Ex-sign
10	Information about manufacturer
11	Serial number of the flowmeter
12	Date of manufacturing
13	Temperature range of the measured medium (Twork)
14	Full flow range (Q)
15	Nominal diameter (DN)

Sensor name plate is produced according to Figure 1.5.

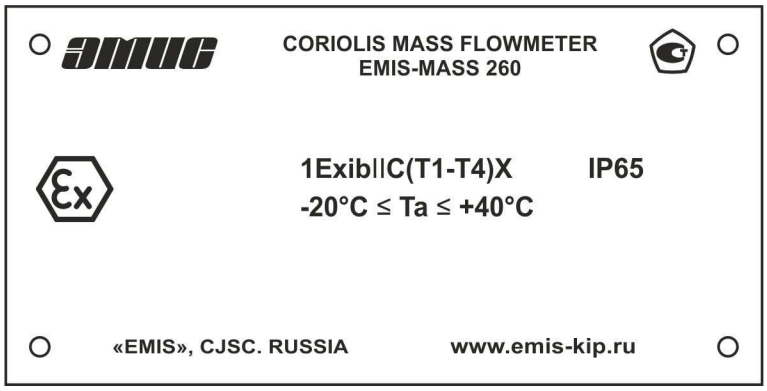


Figure 1.5 – Sensor name plate

Sensor name plate contains the following data:

- Trademark of the manufacturer;
- Flowmeter name;
- Ex-sign (for the flowmeters of “Ex” modification);
- Explosion protection grade (for the flowmeters of “Ex” modification);
- Ambient temperature range;
- IP grade;
- Number of explosion proof certificate and certification agency name (for the flowmeters of “Ex” modification;
- Information about manufacturer.

CAUTION!
Before installation of the flowmeter, make sure that the information on the name plates conforms to the data in the order.

After verification procedure the flowmeter is sealed. Sealing is performed using the seal and wire threaded through the holes in the front cover of the transmitter.

It’s also allowed to use a sealing tape attached to both the transmitter shell and the front cover of the transmitter.

1.7 Delivery set

The base delivery set and the accessories for the flowmeter are shown in Figures 1.6, 1.7 and in Tables 1.12, 1.13.

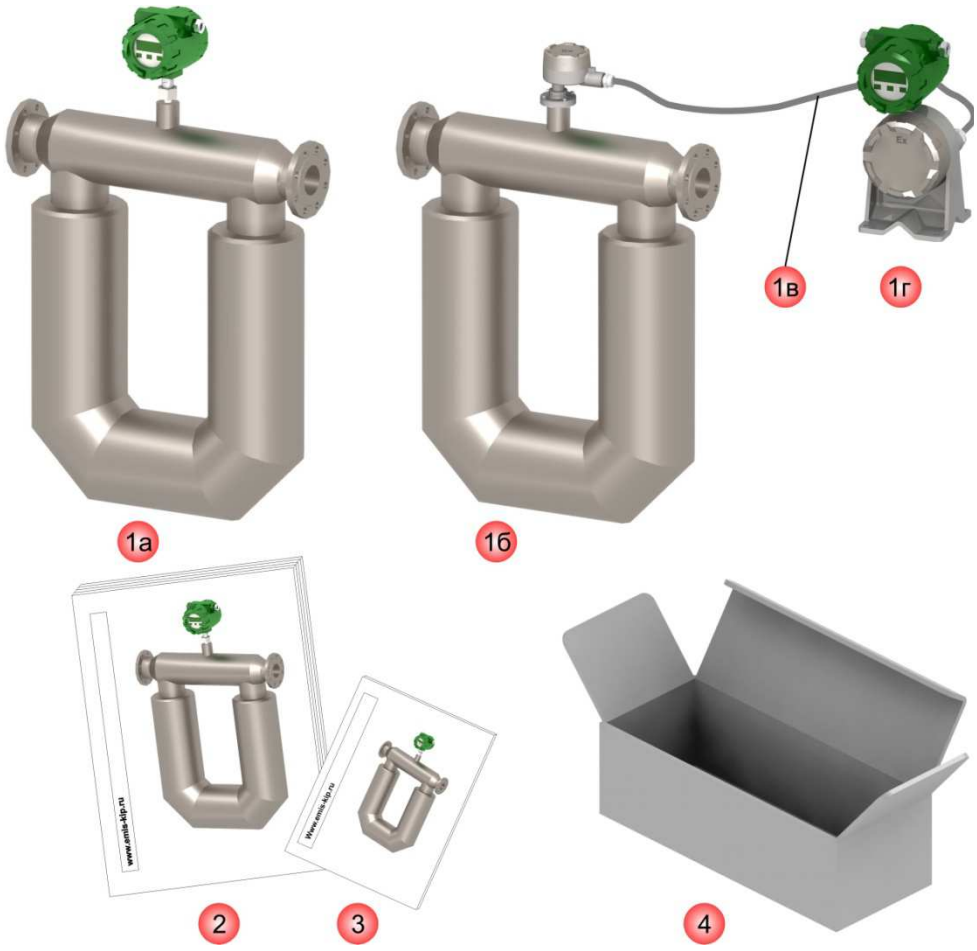


Figure 1.6 – Base delivery set

Table 1.12 – Base delivery set

Item №	Description	Base delivery set	Special order
1	Coriolis Mass Flowmeter «EMIS-MASS 260»	+	Cable length
2	User manual	+	
3	Passport of the flowmeter	+	
4	Packing box	+	
5	Verification methods document	+	
6	«EMIS- Integrator» software	Available at the EMIS company web site	

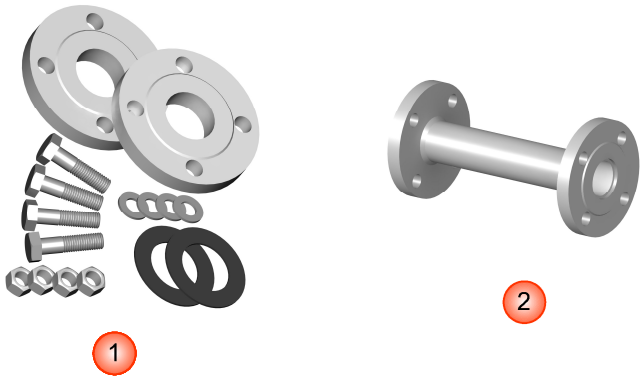


Figure 1.7 Accessories

Table 1.13 - Accessories

Item №	Description
1	Connection kit (flanges, gaskets, stud bolts, nuts, washers) EMIS-MASS 260-CK
2	Flowmeter's replacement mounting part EMIS-VEKTA BT260

CAUTION!

Upon receipt of the flowmeter it is necessary to:

- Check the packaging box for damage;
- Make sure that delivery set is complete;
- Make sure the flowmeter model matches the order data.

If the package is damaged, delivery set or flowmeter model doesn't match the order you should draw up a statement.

1.8 Model codes

"EMIS-MASS 260" flowmeter's model codes are presented in Table 1.14.

The example of the flowmeter's modification for the order is showed below.

	1		2		4		5		7		8		9		10		11		12,13		14
EMIS-MASS 260-	Ex	-	050	-	D	-	L	-	2.5	-	200	-	220	-	A	-	0.25	-	-	-	V

Table 1.14 – Flowmeter model codes

1	Explosion protection
–	General type
Ex	Explosion proof type Ex ibIIC(T1-T4)X for sensor; Exd[ib]IICT6X for transmitter
X	Special order
2	**Nominal diameter (DN)**
010	DN = 10 mm
015	DN = 15 mm
025	DN = 25 mm
040	DN = 40 mm
050	DN = 50 mm
080	DN = 80 mm
100	DN = 100 mm
150	DN = 150 mm
200	DN = 200 mm
X	Special order
3	**Flow range**
–	Typical range in accordance with Table 1.2
X	Special order
4	**Transmitter placement**
I	Integral type
D	Separate type with the connection cable length 3 m
DXX	Separate type with specified connection cable length XX m. Max. length is 300 m.
5	**Measured medium**
L	Liquid
X	Special order
6	**Sensor material**
–	Stainless steel
X	Special order

7	Medium pressure
1.6	Maximum pressure – 1.6 MPa
2.5	Maximum pressure – 2.5 MPa
4.0	Maximum pressure – 4.0 MPa
6.4	Maximum pressure – 6.4 MPa
X	Special order

8	Medium temperature
100	Medium temperature -50…+100 °C
200	Medium temperature -50…+200 °C (separate type only)
350	Medium temperature -50…+350 °C (separate type only)
X	Special order

9	Power supply
24	24V DC (for DN<=100 mm)
220	220V AC
X	Special order

10	Output signals
–	Pulse + digital RS-485 outputs
A	Additional current output 4-20 mA
X	Special order

11	Accuracy class
0.15	Accuracy class 0.15
0.25	Accuracy class 0.25
0.5	Accuracy class 0.5
X	Special order

12	Display
–	Display with basic functionality
X	Special order

13	Connection to the pipeline
–	Flange type
X	Special order

14	Verification
–	Factory calibration
V	Official verification

2 OPERATION AND MAINTENANCE

2.1 Model selection recommendations

One of the most important conditions for reliable operation of the flowmeter and to obtain reliable measurement results is correspondence of the flowmeter's modification to the process parameters. The list of the process parameters required for optimal flowmeter modification selection is presented in Table 2.1.

Table 2.1 – Process parameters for modification selection

Item №	Process parameter
1	Measured medium name
2	Composition and percentage of liquid components
3	Composition and percentage of solid impurities in fluid
4	Composition and percentage of gas inclusions in fluid
5	Measured medium density
6	Measured medium viscosity
7	Flow range
8	Required accuracy
9	Measured medium temperature
10	Pipeline pressure
11	Allowable pressure drop
12	Presence of regulation and control components in the system
13	Pipeline diameter
14	Pipeline orientation at the installation place
15	Ambient temperature
16	Explosion protection grade and requirements

CAUTION!

To avoid erroneous self-dependent selection of the modification of the flowmeter please send the completed questionnaire to the nearest EMIS company representative.

Flowmeter size should be selected according to the actual flow rates in the pipeline, which may differ from the calculated (design) values. Flowmeter size should be chosen so that the actual flow rate of the medium was in the second third of the flow range. Therefore, nominal diameter (DN) of the flowmeter can be either equal or less than the nominal diameter of the pipeline.

When mismatch pipeline diameter and the nominal diameter of the flowmeter tapered transitions can be used. They can be made independently, at that to ensure minimum loss of pressure, the central cone angle must not exceed 30 ºC.

2.2 Safety precautions

Installation, operation, maintenance of flowmeters should be performed by persons studied this manual and safety instructions for working with electrical devices.

All operations on calibration and usage of flowmeters must comply with the requirements for protection against static electricity.

Installation of flowmeter in the pipeline and its removal from the pipeline should be performed without pressure in the pipeline and with the power supply switched off. Electrical connection should also be performed only when the power supply is switched off.

During the installation, commissioning and maintenance shall be prohibited:

- replacement of electronic components when the flowmeter is powered on;
- connecting the flowmeter to the power supply with output voltage other than specified in this manual;
- using electrical devices and tools without protective grounding and also in case of their malfunctions.

During installation the hazardous factors are:

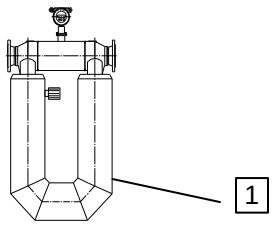
- power supply voltage of 220V AC or higher (in case of the external power supply located in close vicinity of the installation place);
- excess pressure in the pipeline;
- high temperature of the medium.

Operation of flowmeters of “Ex” modification must be performed in accordance with the requirements of Chapter 7.3 of the “Electrical Installations Code” and other regulations of using of electrical equipment in explosive environment.

CAUTION!

Installation and operation of the flowmeter in conditions of pressure or temperature exceeding their maximum allowable values is prohibited.

Do not use the flowmeter with the cover opened, and also without the chassis grounding.



To prevent leakage of the gas filling the sensor’s outer shell, do not open the cover 1.

2.3 Installation on pipeline

2.3.1 Installation location

When selecting the installation place you should follow these rules:

- There should be no strong vibration, high temperatures or strong magnetic fields at the installation place. Therefore, do not install the flowmeter close to transformers, power units and other mechanisms that create vibration and electromagnetic interference.
- The flowmeter should not be installed in the strained section of the pipeline and should not be used as a pillar for the pipeline.
- It is recommended to provide moisture protection for the flowmeter.
- Flowmeter should be installed in easily accessible places. Free space around the flowmeter should be provided for easy installation and maintenance.
- Display of the flowmeter should be installed at a place which is convenient for the operator to read displayed data.
- The installation place of the flowmeter should be selected to ensure a minimum temperature of the transmitter's surface. In direct sunlight the surface temperature may rise by up to 30 degrees compared to the ambient temperature, so if installation in the shade is not possible, it is recommended to use a sunshade.

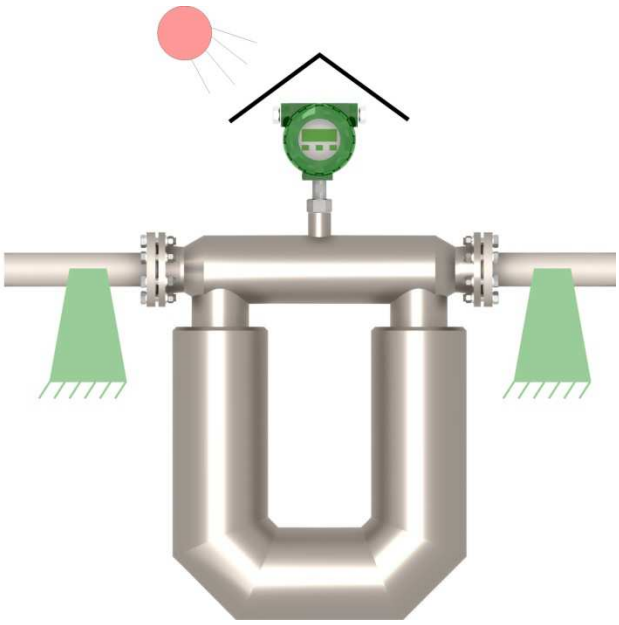


Figure. 2.1 Basic requirements for the installation place

CAUTION!
If there is a strong vibration or pipeline strained at the installation place, it is necessary to provide external support for the pipeline before and after the flowmeter. The support base must be firm. In this case installation of the flowmeter in such places, including mobile units is permitted.

2.3.2 Orientation

Flowmeter can be installed in horizontal, vertical or inclined sections of the pipeline. It is optimal to install the flowmeter in horizontal section.

The flowmeter should be installed so that its measuring tubes are always filled with fluid and the arrow on the sensor body coincided with the flow direction. In these conditions, the flowmeter will operate properly in any orientation.

Flowmeter does not require collateral straight pipeline sections before and after the flowmeter, nor installation of additional equipment to level the flow profile (flow conditioning plates, etc.). But if two or more flowmeter are installed in the same section of the pipeline, the distance between them should be at least 2 m.

Installation recommendations are presented in Figure 2.2.

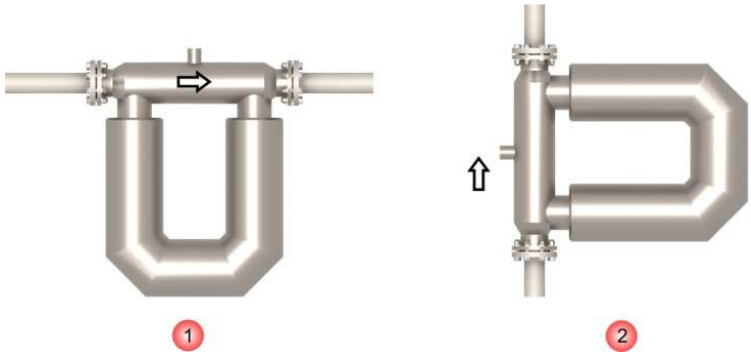


Figure 2.2 Recommendations for installation

Table 2.2 – Notes for Figure 2.2

Pic №	Recommendations
1	It is recommended to install the flowmeter tubes downward to improve their filling with fluid and to prevent accumulation of gas in them.
2	For vertical or inclined pipeline orientation it is recommended to install the flowmeter in a pipeline section with the upward flow direction to improve filling of the pipe with fluid.

In the event of bending pipe it is recommended to install the flowmeter in the lower section of the pipeline.

Do not install the flowmeter on a horizontal pipe before the drainage section with free flow, because in this case filling the flowmeter's tubes wit fluid is not guaranteed.

2.3.3 Pipeline preparation

To prepare for the installation of the flowmeter, it is necessary:

- Check the completeness of the connection kit and conformity of all mounting parts to the flowmeter's modification;
- Cut the pipeline section of length Linst

$$Linst = Lm + 2*Lg + 2*Lf, \quad (2.1)$$

where Lm – flowmeter length (see **Appendix A**);

Lg – gasket thickness;

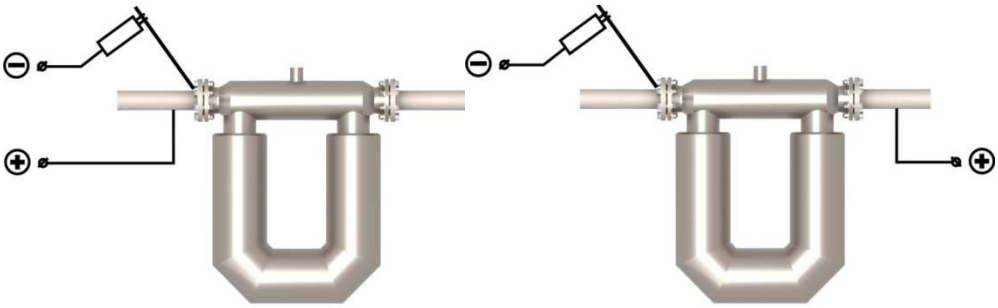
Lf – connection kit flange thickness minus depth of landing on the pipeline;

- Install connection kit flanges on the pipeline;
- Using the flowmeter's replacement mounting part, fix and center flanges and weld them to the pipeline.

CAUTION!

In the process of installation the flowmeter may be used instead of the replacement mounting part only in the following cases:

- installation is carried out using a gas welding;
- when installing using an electric arc welding the power source is connected in a way that prevents the welding current to run through the flowmeter - see Figure 2.3.



Right Wrong

Figure 2.3 Connecting the power source for arc welding using the flowmeter

As a result, the installation place must appear as shown in Figure 2.4, where the length L is the sum of the length of the flowmeter and thickness of two gaskets.

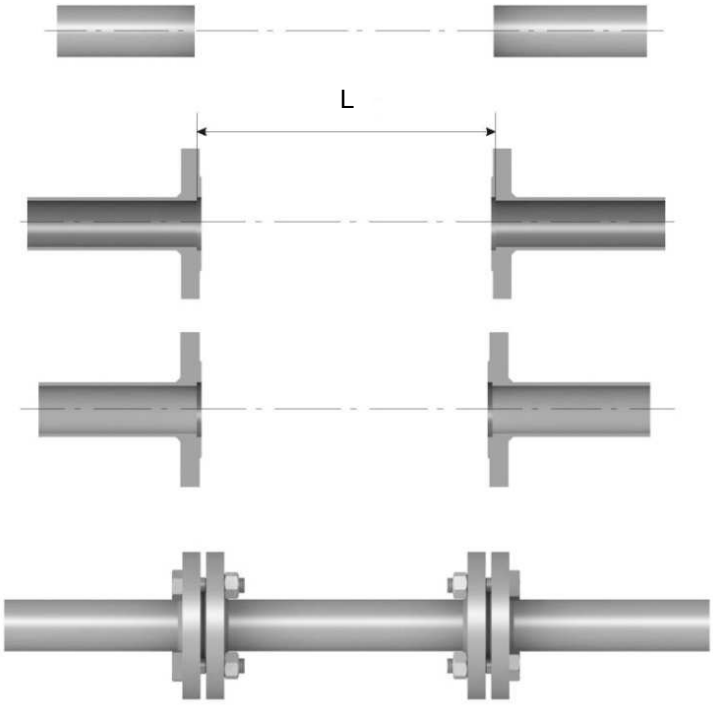


Figure 2.4 Pipeline preparation for installation of the flowmeter

CAUTION!

When using filters or gas separators, the length L should be enough for their installation.

2.3.4 Installation

Prior to installation, it is necessary:

- Thoroughly clean the pipeline of cinder, sand, and other solid particles;
- Inspect the flanges and the measuring tubes of the flowmeter and remove solid mechanical and other particles from them;
- Remove the preservative grease from the flowmeter, by passing through it kerosene, gasoline or diesel fuel.

To install the flowmeter in the pipeline do the following steps (see Figure 2.5):

- Arrange the flowmeter so that the arrow on the sensor's body corresponds to the normal direction of flow;
- Slide the bolts through the holes of one of the pipeline flanges and flowmeter's flange, put washers and nuts. Nuts should not be finally tightened yet;
- Put the gasket between the pipeline flange and flowmeter's flange and align it. It is recommended to avoid protrusion of the gasket into the pipeline opening;
- Install the gasket between the other pair of flanges; slide the bolts through the holes of the flanges, put washers and nuts. Nuts should not be finally tightened yet;
- Tighten the nuts in the sequence shown in Figure 2.6.

When installing the flowmeter bending and torsional load on the joints, and also mated flanges misalignment should be minimized.

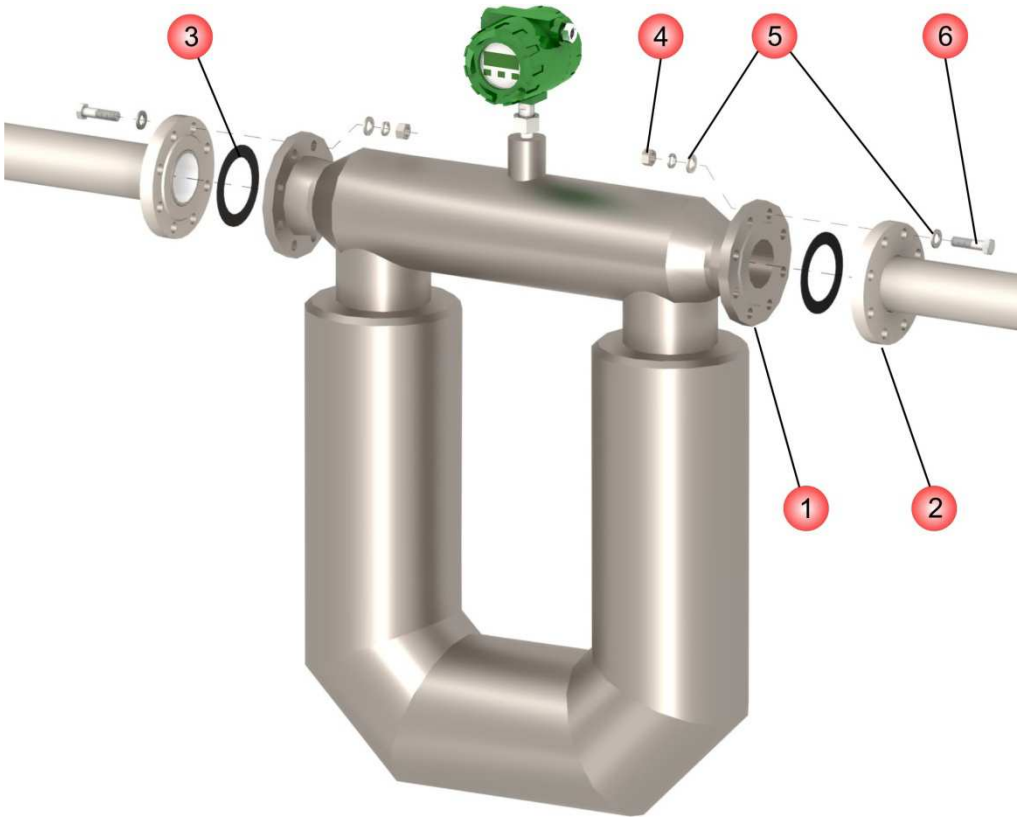


Figure 2.5 Installation of the flowmeter in the pipeline

Table 2.3 – Notes for Figure 2.5

Item №	Mounting part
1	Flowmeter flanges
2	Connection kit flanges
3	Gaskets
4	Nuts
5	Washers
6	Bolts (or stud bolts)

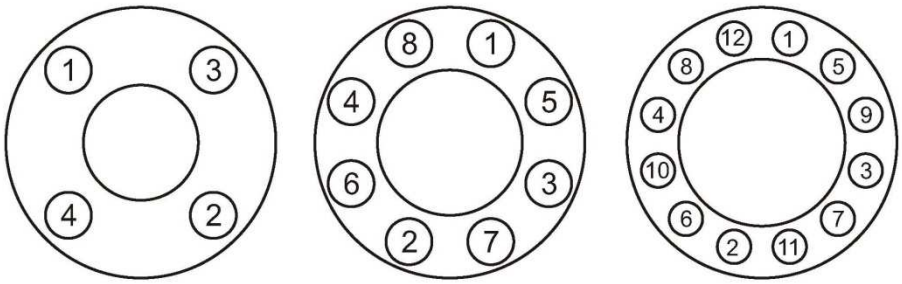


Figure 2.6 - The sequence of tightening the flange bolts

Transmitter of the separate type of the flowmeter can be mounted as shown in Figure 2.7. Transmitter can be mounted with brackets or clamps to the rack, pipe or wall.

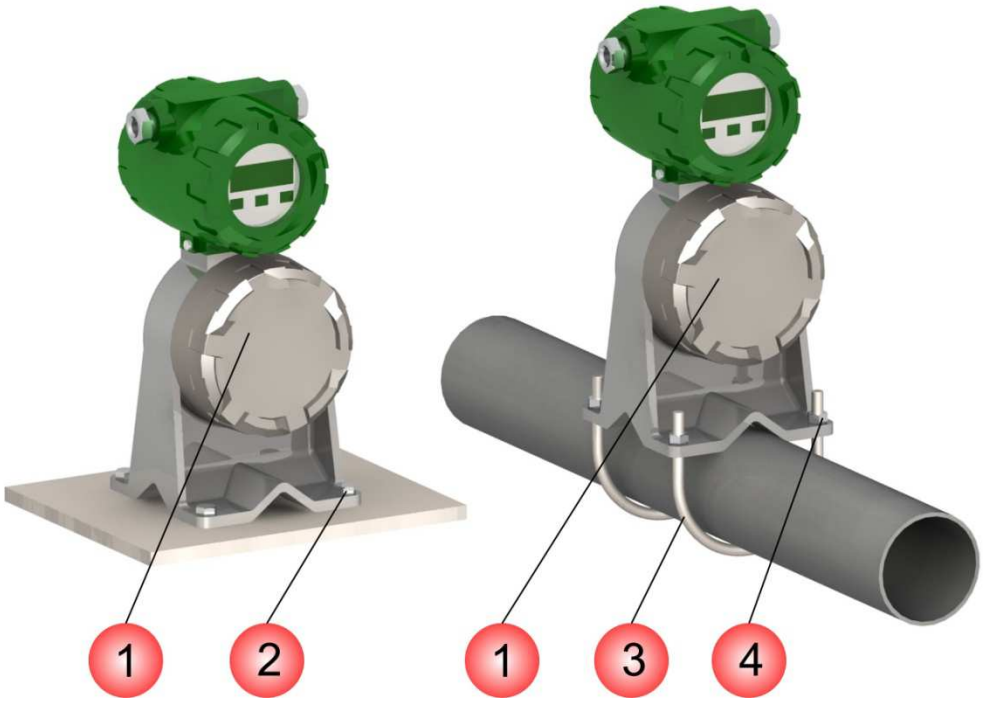


Figure 2.7 – Installation of transmitter of separate type modification

Table 2.4 – Notes for Figure 2.7

Item №	Mounting part
1	Transmitter base
2	Bolts
3	Clamp
4	Nuts

CAUTION!

Do not install the transmitter with the cable entry directed vertically upwards.

2.3.5 Thermal insulation

If thermal insulation of the pipeline and the flowmeter is necessary, see the recommendations in Figure 2.8.

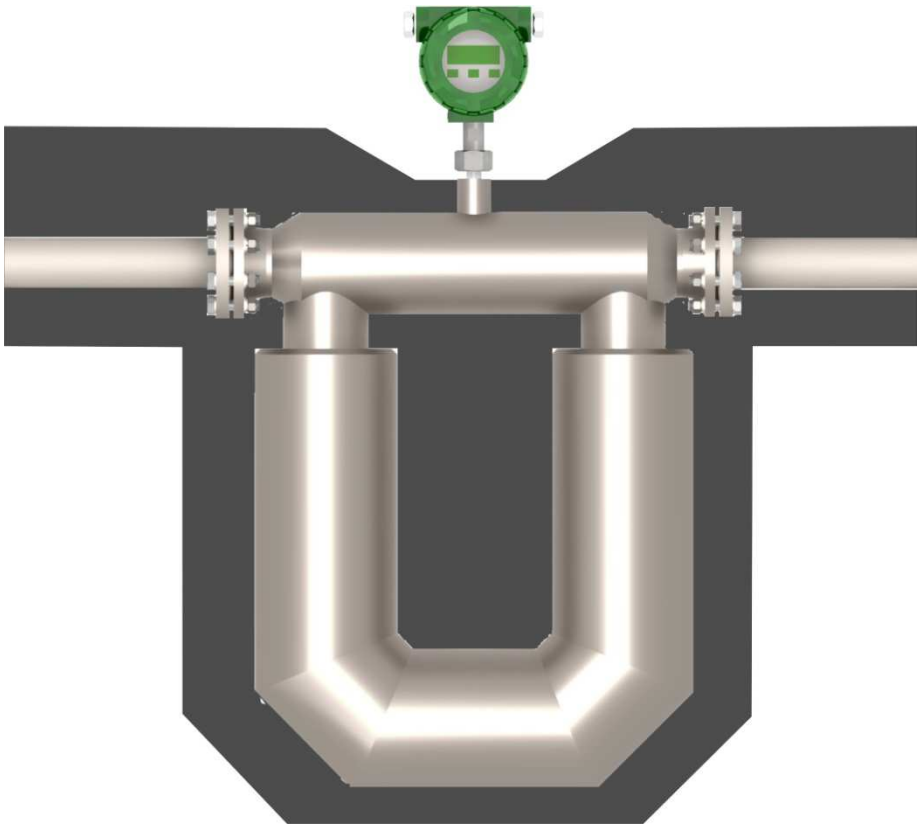


Figure 2.8 – Recommendation for thermal insulation of the flowmeter

2.3.6 Cooling

For high temperature modification of the flowmeter (with medium temperature above +200 ℃) possibility of external cooling is p rovided (see Figure 2.9).

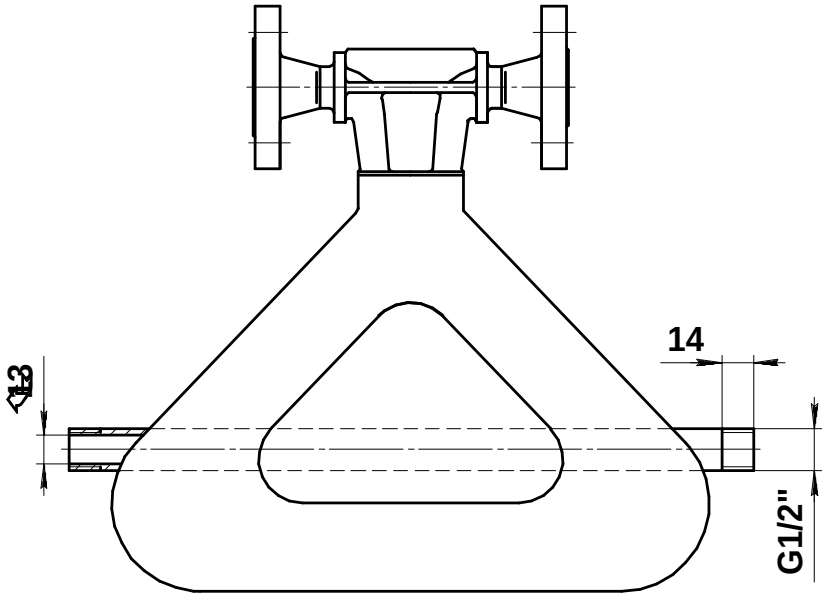


Figure 2.9 – External cooling supply

2.3.7 Transmitter rotation

If in the process of installation the front side of the transmitter appeared to be not in front of the user and display is not visible, it is possible to rotate the transmitter at an angle of 90° or 180°, so that the display is fac ing the user. To do this, unscrew the four bolts (1) (see Figure 2.10). Then turn the transmitter (2) by 90° or 180° in the desired direction and tighten those 4 bolts to ensure sealing.

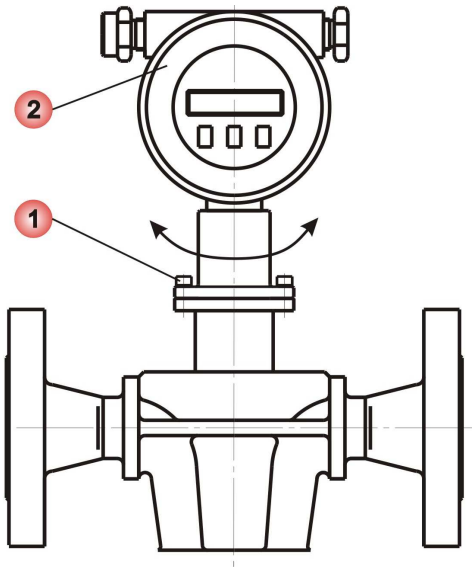


Figure 2.10 – Rotation of the transmitter

CAUTION!
To avoid excessive twisting of wires inside the flowmeter do not turn the transmitter at an angle over 180° regarding its ini tial position.

2.4 Wiring

2.4.1 Basic operations

Electrical connections should be performed in the following sequence (see Figure 2.11):

- Remove the back cover (1) of the transmitter;
- Lead signal cables (2) and power cable (7) through the cable entries (3)
- Loose the terminal block screws (4);
- Connect wires according to the wiring diagram shown in Appendix C;
- Tighten the terminal block screws;
- Tighten the clamp of the cable entry;
- If necessary, install the blind plug (5) instead of the unused cable entry;
- Connect the ground cable to the ground terminal (6);
- Tighten the cover of the transmitter.

Figure 2.11 - Electrical connection of the flowmeter

Table 2.5 – Notes for Figure 2.11

Item №.	Description
1	Back cover of the transmitter
2	Signal cable
3	Cable entries
4	Terminal block
5	Blind plug
6	Ground terminal
7	Power cable

Maximum length of the power cable is 300 m with minimum wire section 0.8 mm^2 (AWG18).

Connecting to the current and pulse outputs should be performed with a twisted pair wire with the maximum length of 150 m and minimal wire section 0.5 mm^2 (AWG20).

Sensor and transmitter of the flowmeter of separate type are connected through a special 9-core shielded cable with maximum length of 300 m. Connection diagram is shown in Figure C.1 of Appendix C.

After mounting and electrical connection the zero point adjustment should be performed (see paragraph 2.5.4 “Zero point adjustment”).

CAUTION!

When using the flowmeter in hazardous areas, apply the requirements for explosion protection provided in paragraph 2.4.2 "Installation with explosion protection"

2.4.2 Installation with explosion protection

Installation of flowmeters in explosive environment must be performed in accordance with requirements of:

- This manual;
- Section 3.4 of “Operational Code for Electrical Installations”;
- Section 7.3 of “Electrical Installations Code”;
- GOST R 51330.0;
- GOST R 51330.1;
- GOST R 51330.10;
- Instruction BCH332-74/MMCC (“Instructions for installation of electrical equipment, power and lighting lines in hazardous areas”);
- Other regulations in force within the enterprise.

During installation you should pay attention to the specific operating conditions mentioned in Section 1.5 "Explosion protection".

Before installation the flowmeter should be inspected. You should pay special attention to explosion proof grade labels, warning labels, make sure that there is no damage to the flameproof shell and flow sensor. Also make sure that grounding terminal and the seals for cables and covers are available and in good condition, also check the connecting cables condition.

Upon completion of the electrical installation the electrical resistance of the ground line should be checked. It must not exceed 1 Ohm. A copper wire with section of at least 2.5 mm2 (AWG13) should be used for grounding.

Unused cable entry must be closed with the end cap supplied by the flowmeter’s manufacturer or other end cap complied with GOST R 51330.1;

During installation, check the explosion-proof surfaces of mounting parts involved in providing explosion protection. Scratches, dents, chips on the explosion-proof surfaces of those parts (which are in the explosion path), are not permitted.

After the completion of the electrical connections it is necessary to close the transmitter covers firmly and put the latch lock on the covers.

2.4.3 Wiring recommendations

During electrical connection of the flowmeter you should follow these recommendations:

- Wire cores must be cleaned and fixed on terminals to prevent a short circuit between each other and the body of the flowmeter (ground);
- It is recommended to use separate power supplies or a multichannel power supply with isolated channels to power the flowmeter and each of its outputs;
- If it is necessary to calculate the load resistor value, the total load impedance should be calculated as the sum of the cable resistance, external load resistance, resistance of safety barriers, load resistance of the secondary equipment;
- To minimize interference when transmitting of analog output signal 4-20 mA and digital signal it is recommended to use a shielded twisted pair cable. Grounding of the cable should be provided only on one side of the cable (near the power supply);
- It is not recommended to lay the signal cables in the same conduit with power wires, and also near sources of strong electromagnetic fields. If necessary, grounding of signal wiring can be done at any point in the signal circuit. For example, it is possible to ground the negative terminal of the power supply. The electronics housing is grounded to the sensor housing.

2.4.4 Waterproofing

The flowmeter meets all the requirements for moisture protection grade specified in the "Technical Specifications" section.

In order to ensure the required protection grade, after the installation or maintenance of the flowmeter, the following requirements should be fulfilled (see Figure 2.12):

- Seals in the transmitter should not have dirt or damage. If necessary, clean or replace the seals. It is recommended to use the original sealing elements from the manufacturer.
- Electrical cables should fit the cable entry and must not be damaged.
- Covers and the cable entries must be tightened firmly.
- Unused cable entries must be plugged.
- Just before the cable entry the cable should have U-shaped loop to prevent any liquid from going into transmitter when the liquid flows down the cable.

Do not install the transmitter with the cable entry directed vertically upwards.

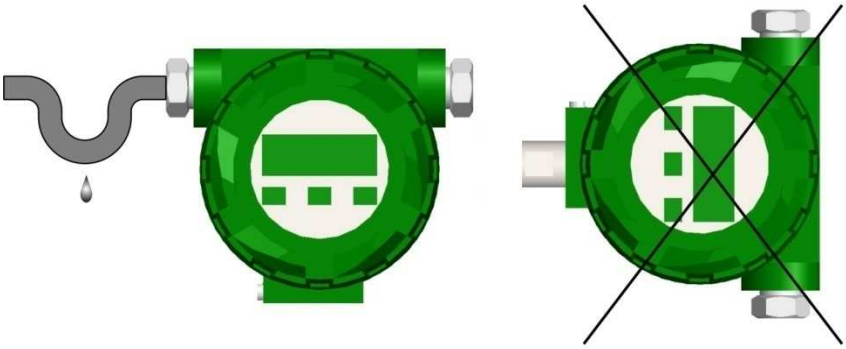


Figure 2.12 Recommendations for orientation of cables and cable entries

2.4.5 Grounding

Transient processes induced by lightning, welding, big power-consuming equipment or switches may lead to distortion of the flowmeter's measuring or damage it. For protection from transient processes one should provide a connection of the ground terminals located on the transmitter body (see Figure 2.13), with the ground through a wire, designed for operation under high currents.

For grounding, it is recommended to use copper wire of at least 2.5 mm^2 (AWG13) section. Ground wires should be as short as possible and have a resistance of less than 1 Ohm.

Transmitter can be grounded through the pipeline, if the pipeline provides the ground.

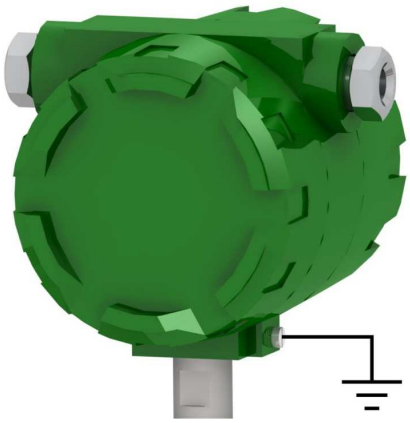


Figure 2.13 Grounding

CAUTION!
There should be no potential applied or induced on the ground wire. Do not use the same wire for grounding of two or more devices.

2.5 Operation and maintenance

2.5.1 Basic recommendations

To ensure reliable operation of the flowmeter and maintain accuracy it is necessary to satisfy the following requirements:

- To prevent damage to the measuring tubes of the flowmeter because of hydroblow, opening / closing valves on the inlet pipe should be done gradually;
- Operation at flow rates close to the upper limit of the full flow should last no more than 2 hours per day;

2.5.2 Power-Up

Right after power-up the flowmeter performs a self-test, and if it succeeds, the flowmeter begins to measure flow, to generate output signals and display the measured values.

2.5.3 Display operating

Controlling of the flowmeter's display is performed via three buttons of optical type, below the display. Thus, display operating doesn't require opening the front cover of the transmitter, which is important in explosive environment, in conditions of high humidity or precipitations, and other conditions with a high probability of contamination of the internal structural elements of transmitter or ingress of moisture, liquids, foreign objects, etc.

To "push" the optical button one should briefly put a finger or other opaque object close to the display glass in the area of the button. At that time the LED next to the display lights for a moment.

Flowmeter can display the measured parameters shown in Table 2.6. To change the display page (next pair of parameters), press the ↓ button. Display sequence corresponds to Table 2.6.

Table 2.6 – Displayed parameters sequence

Displayed parameter	*Display format*
Mass flow rate Mass total	Flow XXX.XXX Mass XXX.XXX
Volume flow rate Volume total	Flow XXX.XXX Volm XXX.XXX
Density Temperature	Den XXX.XXX Temp XX.X

If the displayed value becomes more than 999.999, the units are automatically switched to bigger ones to be able to display that value.

If no button is pressed within two minutes, flowmeter is automatically switched to display mass or volume flow rate (Menu items 1 or 2), depending on the state of the menu item 47 "First Menu".

The flowmeter can be configured via display menu. The structure of the menu is shown in Figure 2.14, description of the menu items presented in Table 2.7.

In the editable menu items press «E» button to switch to edit mode.

- If the menu item has several predefined options press «↓» or «→» to move between those options. The currently selected option is flashing. To accept selection press «E». The message «Saved? Y N» about saving changes will appear. Press «↓» or «→» to move between «Y» (yes) and «N» (no) options. Select «Y» to accept changes or «N» to cancel, then press «E» to quit edit mode.

- If the menu item has numeric value its editing is performed by changing the digits one by one and moving to the next digit on the right. The digit in currently selected position is flashing. Press «↓» to increment the digit in current position from 0 to 9. To move to the next digit press «→». Press «E» to finish editing, then select «Yes» to accept changes or «No» to cancel, then press «E» to quit edit mode.

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Root menu

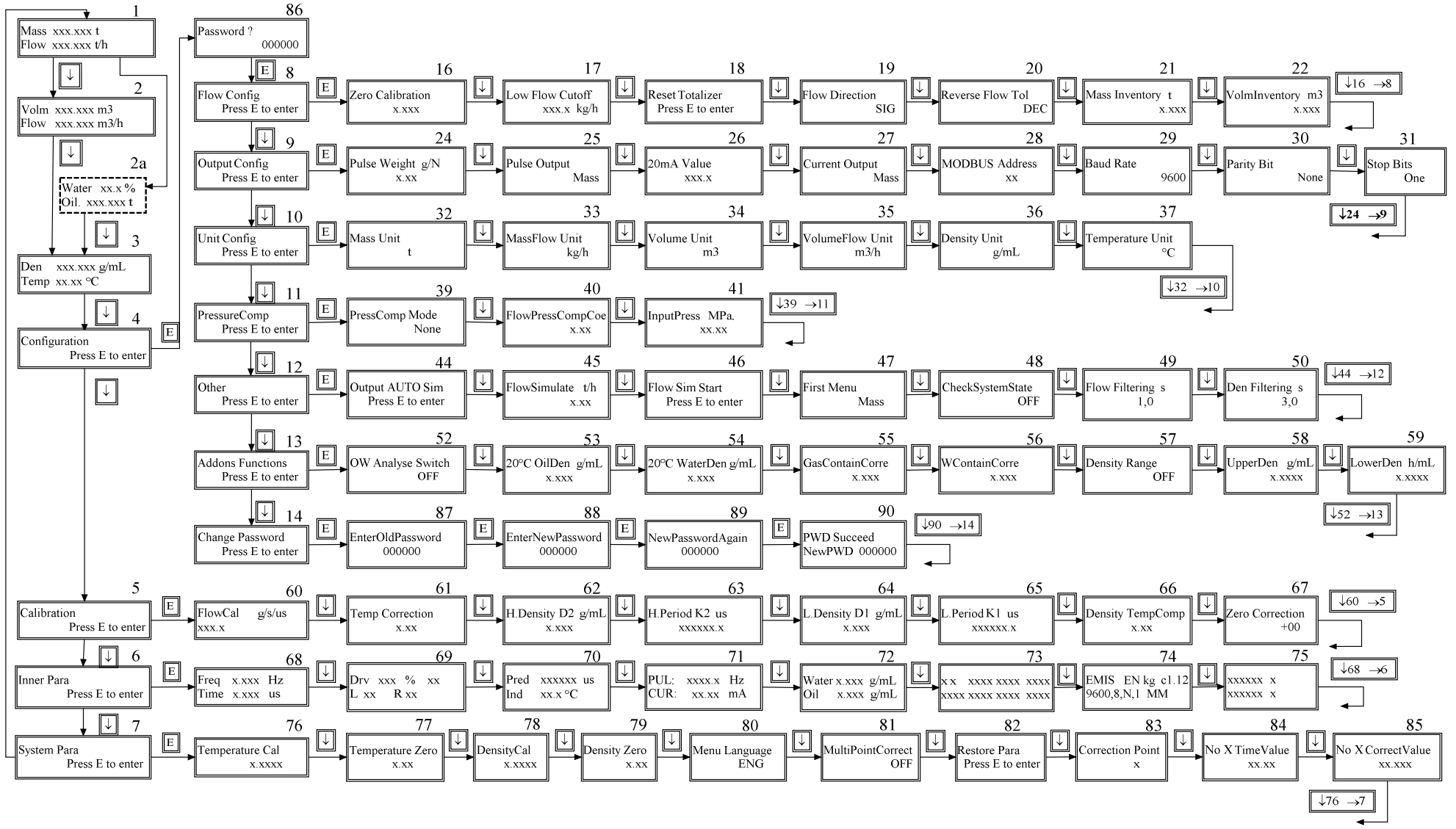

Figure 2.14 Display menu structure

Table 2.7 – Displayed parameters

Menu item	Indication format	Button actions	Description
	Measured parameters display		
0	EMIS-Yinuo Ver.2.28. 2012.03	↓1	Version and data of electronics. Showed on flowmeter's power-up.
1	Flow XXX.XXX Mass XXX.XXX	↓2, →0	Total mass and instant mass flow rate.
2	Flow XXX.XXX Volm XXX.XXX	↓3, →1	Total mass and instant volumetric flow rate. This menu item is not displayed when Menu item 52 "OW Analyze Switch" if set to On.
2a	Oil XXX.XXX Water XXX %	↓4, →1	Mass flow rate of pure oil and percentage of water in the oil-water. This menu item is displayed only if Menu item 52 "OW Analyze Switch" if set to On.
3	Den XXX.XXX Temp XX.XX	↓4, →1	Density and temperature of the measured medium.
4	**Configuration** Press «E» to enter	↓5, →1, E86	Press «E» button to enter the submenus for configuring the flowmeter.
	Submenus of the "Configuration" menu		
86	Password? 000000	E8	The following submenus can be accessed only after entering the 6-digit password. If the entered password is invalid a message "Wrong password" will be displayed. To return to the Menu item 4 "Configuration" press «→». To enter the password again press «↓».
8	**Flow Config** Press «E» to enter	↓9, →4, E16	Allows user to specify low flow cutoff, flow direction and the way of its counting.
16	Zero Calibration X.XXX us	↓17, →8	Zero point adjustment. The value displayed is the time delay between the signals coils, taken as zero point. Press «E» to start zeroing procedure described in paragraph 2.5.4.
17	Low Flow Cutoff X.XXX kg/h	↓18, →8, E − edit	If the current mass flow rate is less than specified Low Flow Cutoff value then the flow rate is assumed as zero and totalizers will pause.
18	Reset Totalizer Press «E» to enter	↓19, →8, E − reset	Press «E» to reset mass and volume totalizers (resettable totalizer).
19	Flow Direction SIG BID	↓20, →8, E − edit	Option of direct («SIG») or reverse («BID») direction of flow. If «SIG» is chosen then only direct flow will be accumulated (direction corresponding to the arrow on the sensor body). If «BID» is chosen then flow will be counted on both direct and reverse directions.

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Menu item	Indication format		Button actions	Description
20	Reverse Flow Tol	DEC INC	↓21, →8, E − edit	The way of counting reverse flow, whether it will be added («INC») or subtracted («DEC») from the accumulated total mass and volume.
21	MassInventory	X.XXX	↓22, →8	Accumulated total mass. This value is also displayed in Menu item 1 “Flow Mass”.
22	VolmInventory	XXXX.XX	↓16, →8	Accumulated total volume. This value is also displayed in Menu item 2 “Flow Volm”.
9	**Output Config** Press «E» to enter		↓10, →4, E24	Configuration of the outputs of the flowmeter.
24	Pulse Weight	XXX. XX g/N	↓25, →9, E − edit	Input mass flow rate, volume flow rate or density corresponding to one pulse on the pulse output.
25	Pulse Output	Mass Volm Dens	↓26, →9, E − edit	The pulse output can be configured to denote mass flow rate (“Mass”), volumetric flow rate (“Volm”) or density (“Dens”) of the medium.
26	20mA Value	XXX.X	↓27, →9, E − edit	Input mass flow rate, volume flow rate or density corresponding to 20mA on the current output.
27	Current Output	Mass Volm Dens	↓28, →9, E − edit	The current output can be configured to denote mass flow rate (“Mass”), volumetric flow rate (“Volm”) or density (“Dens”) of the medium.
28	MODBUS Address	XXX	↓29, →9, E − edit	Address of the flowmeter in Modbus network.
29	Baud Rate	9600 4800 2400 1200	↓30, →9, E − edit	Data transfer baud rate in Modbus network.
30	Parity Bit	No Even Odd	↓31, →9, E − edit	Parity control in data transfer protocol. Select «NO» for no parity; «Even» for 1 even parity bit; «Odd» for 1 odd parity bit.
31	Stop Bits	One Two	↓24, →9, E − edit	Select one or two stop bits in data transfer protocol in Modbus network.

Menu item	Indication format		Button actions	Description
10	**Unit Config** Press «E» to enter		↓11, →4, E32	Select units for parameters displayed in the menu items 1, 2, 3.
32	Mass Unit	g, kg, t	↓33, →10, E – edit	Select units for mass totalizer.
33	MassFlow Unit	g/s, kg/s, kg/min, t/min, t/h	↓34, →10, E – edit	Select units for mass flow rate.
34	Volume Unit	mL, L, m^3	↓35, →10, E – edit	Select units for volume totalizer.
35	VolumeFlow Unit	mL/s, L/s, L/min, m^3/min, L/h, m^3/h	↓36, →10, E – edit	Select units for volumetric flow rate.
36	Density Unit	g/mL, kg/L	↓37, →10, E – edit	Select units for density.
37	Temperature Unit	°C, F	↓32, →10, E – edit	Select units for temperature.
11	**PressureComp** Press «E» to enter		↓12, →4, E39	Switching On/Off and changing parameters of pressure compensation for flow.
39	PressComp Mode	None Manu Auto	↓40, →11, E – edit	Pressure compensation modes: Select «None» to disable pressure compensation; select «Manu» for manual compensation, when the actual pressure value is entered manually in the Menu item 41; select «Auto» for automatic pressure compensation, when actual pressure is measured by an external pressure sensor, connected to the flowmeter's corresponding terminals.
40	FlowPress CompCoe	X. XX	↓41, →11, E – edit	Coefficient of pressure compensation for flow as percentage of calibration coefficient correction for pressure deviation of 1MPa. Default value is 0.01 %/MPa.
41	InputPress MPa	XX. XX	↓39, →11, E – edit	Actual pressure value for manual compensation mode.
12	**Other** Press «E» to enter		↓13, →4, E44	Miscellaneous functions such as flow simulation, etc.
44	Output AUTO Sim Press «E» to enter		↓45, →12, E – edit	Press «E» to start automatic flow simulation procedure. The sequence of frequency and current test signals appears on the flowmeter's outputs. Signal on the current output changes from 4 to 20 mA in steps of 0.5mA; frequency on the pulse output changes from 0 to 12000 Hz in steps of 375 Hz. Values change every 5 seconds.

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Menu item	Indication format		Button actions	Description
45	FlowSimulate t/h	X. XX	↓46, →12, E – edit	Input mass flow rate used in flow simulation. Signals on pulse and current outputs will correspond to that flow rate.
46	Flow Sim Start Press «E» to enter		↓47, →12, E – edit	Flow simulation mode starts by pressing «E». Simulated flow rate is specified in the Menu item 45. Simulation stops after pressing «↓» или «→».
47	First Menu	Hold Mass Volm	↓48, →12, E – edit	Select the menu item, which will be displayed if no button is pressed within 2 minutes. Select “Mass” to move to Menu item 1, “Volm” to move to Menu item 2. If “Hold” option is selected moving to other menu items will not occur.
48	CheckSystem State	OFF ON	↓49, →12, E – edit	Enable/disable system check function.
49	Flow Filtering s	X.XXX	↓50, →12, E – edit	Flow rate averaging time from 0.5 to 10 s in steps of 0.5 s.
50	Den Filtering s	X.X	↓44, →12, E – edit	Density averaging time from 0.5 to 30 s in steps of 0.5 s.
13	**Addons Function** Press «E» to enter		↓14, →4, E52	Entering parameters for measurement of two-component media.
52	OW Analyse Switch	OFF ON	↓53, →13, E – edit	Enable/disable oil-water analyze function.
53	20ºC OilDen	X.XXX g/mL	↓54, →13, E – edit	Density of pure oil under standard conditions.
54	20ºC WaterDen	X.XXX g/mL	↓55, →13, E – edit	Density of pure water under standard conditions.
55	GasContainCorre	X.XXX	↓56, →13, E – edit	Flow compensation by percentage of gas in the oil-water. It works only if oil-water analyze function is enabled in the Menu item 52.
56	WContainCorre	X.XXX	↓57, →13, E – edit	Flow compensation by percentage of pure water in the oil-water (not realized in current versions of flowmeters).
57	Density Range	OFF ON	↓58, →13, E – edit	Enable/disable density range check. When enabled and If density of the medium is out of range specified in menu items 58 and 59 then the volumetric flow will not be calculated.
58	UpperDen	X.XXXX	↓59, →13, E – edit	The upper limit of density range (see Menu item 57).
59	LowerDen	X.XXXX	↓52, →13, E – edit	The lower limit of density range (see Menu item 57).

Menu item	Indication format		Button actions	Description	
14	**Change Password** Press «E» to enter		↓8, →4, E87	Password changing is used for protection against unauthorized access to the settings of the flowmeter.	
87	EnterOld PassWord	000000	↓→ edit, E88	Input current password	If the entered password is invalid a message “Wrong password” will be displayed. To return to the Menu item 14 “Change Password” press «→». To enter the password again press «↓».
88	EnterNew PassWord	000000	↓→ edit, E89	Input new password	
89	NewPassWord Again	000000	↓→ edit, E90	Confirm new password	
90	PWD Succeed	NewPWD 000000	↓14, →14, E14	New password is displayed	
5	**Calibration** Press «E» to enter		↓6, →1, E60	Setting of calibration parameters provided for measuring flow, density, temperature.	
60	FlowCal	X.XXX g/s/us	↓61, →5, E – edit	Calibration coefficient **K**.	
61	Temp Correction	X.XX%	↓62, →5, E – edit	Temperature correction coefficient for flow rate as percentage of calibration coefficient correction for temperature deviation of 100°C.	
62	H.Density D2	X.XXX g/mL	↓63, →5, E – edit	High density value corresponding to the medium of high density (water). Used for calibration for density measuring.	
63	H.Period K2	XXXXXX.X us	↓64, →5, E – edit	Measuring tubes oscillation frequency for the medium of high density (water). Used for calibration for density measuring.	
64	L.Density D1	X.XXX g/mL	↓65, →5, E – edit	Low density value corresponding to the medium of low density (air). Used for calibration for density measuring.	
65	L.Period K1	XXXXXX.X us	↓66, →5, E – edit	Measuring tubes oscillation frequency for the medium of low density (air). Used for calibration for density measuring.	
66	Density TempComp	X.XX %	↓67, →5, E – edit	Temperature correction coefficient for density as percentage of measured density correction for temperature deviation of 100°C.	
67	Zero Correction	+00	↓60, →5, E – edit	Correction of the zero flow point in the range of -19 to +19.	

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Menu item	Indication format	Button actions	Description
6	**Inner Para** Press «E» to enter	↓7, →1, E68	Inner parameters of the flowmeter used for diagnostic purposes.
68	Freq XX.XX Hz Time XX.XX us	↓69, →6	Measuring tubes oscillation frequency. Current time delay between left and right signal coils
69	Drv XXX %, YY L XX mV R XX mV	↓70, →6	Drive coil load as percentage (XXX) and its standard deviation within 8 seconds as percentage (YY). Voltage on the left (L) and right (R) signal coils.
70	Pred XXXXX.XX us Ind XX.X °C	↓71, →6	Measuring tubes oscillation period. Internal temperature of the flowmeter.
71	PUL: XXXX.X Hz CUR: XX.XX mA	↓72, →6	Frequency of the signal on the pulse output. Current value on the current output.
72	Water X.XXX g/mL Oil X.XXX g/mL	↓73, →6	Density of water in oil-water under working conditions. Density of oil in oil-water under working conditions.
73	X X XXXX XXXX XXXX XXXX XXXX XXXX XXXX	↓74, →6	Internal parameters for pressure compensation mode.
74	EMIS EN kg cX.XX 9600, 8, N, 1 tY.YY	↓75, →6	Menu language (EN), version of the display menu (X.XX), Modbus data format, register map version (Y.YY)
75	XXXXXX 1 XXXXXX 0	↓68, →6	Display low volume flow cutoff (L/h), totalizer mode (0 – disabled, 1 – enabled), low density cutoff (g/mL), bytes order for float point values (default value is 0).
7	**System Para** Press «E» to enter	↓1, →1, E76	System parameters of the flowmeter. **Intended to use for the representatives of the manufacturer only.**
76	Temperature Cal X.XXXX	↓77, →7, E – edit	Correction coefficient of the temperature Tk for simulation mode (in the range of 0.9 – 1.1). T= Tk ×Tdev +T0. (Tdev is temperature deviation).
77	Temperature Zero X.XX	↓78, →7, E – edit	Zero temperature T0 for simulation mode (in the range of -20C° to +20 C°).
78	DensityCal X.XXXX	↓79, →7, E – edit	Correction coefficient of the density ρk for simulation mode (in the range of 0.9 – 1.1). ρ= ρk× ρdev + ρ0. (ρdev is density deviation).
79	DensityZero X.XX	↓80, →7, E – edit	Zero density ρ0 for simulation mode (in the range of -0.1 g/cm^3 to +0.1 g/cm^3).

Menu item	Indication format		Button actions	Description
80	Menu Language	RUS ENG	↓81, →7, E – edit	Select display menu language. Switching from Russian language to English is possible only via Modbus.
81	MultipointCorrect	OFF ON	↓82, →7, E – edit	Enable/disable multipoint correction function used for correction of the calibration coefficient in several points of flow rate (time delay).
82	Restore Para Press «E» to enter		↓83, →7, E – edit	Restore of all coefficients and settings of the flowmeter, except for calibration parameters in the menu items 60-67, to factory defaults.
83	Correction Point	X	↓84, →7, E – edit	Number of correction coefficient (0 – 7), which values are specified in the menu items 84 and 85.
84	No X TimeValue	YY.YYY	↓85, →7, E – edit	The value of time delay between left and right signal coils (YY.YYY μs) for the correction coefficient number X.
85	No XCorrectValue	XX.XXX	↓76, →7, E − edit	Correction coefficient (in the range of 0.9 to 1.1) applied to the calibration coefficient **K** for time delay point specified in the menu item 84.

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2.5.4 Zero point adjustment

After installation and electrical connection a zero point adjustment (zero calibration) procedure should be performed. This procedure sets the base point corresponding to zero flow. Without actual flow there is a certain time delay between signal coils anyway, that delay assumed as zero point. To perform this procedure, follow these steps:

- Apply power to the flowmeter and let it warm up for at least 30 minutes;
- Let the measuring medium flow through the flowmeter, as long as the thermal balance is established;
- Close the valve located after the flowmeter;
- Make sure that the flowmeter's tubes are completely filled with fluid;
- Close the valve located before the flowmeter;
- Make sure that the fluid in the flowmeter is completely still;
- Staying in the root menu (see Figure 2.14) press ↓ button several times to move to the Menu item "Configure". Press E button and enter the password (default password is 000000). To enter the password press ↓ to increment the currently selected digit, to move to the next digit press → button. After successful password entering a message "Zero calibration" will appear. Press E to start zero calibration procedure. A message "Zeroing?" will appear. Press E to confirm that. Zero calibration procedure lasts for 30 seconds, the remaining time is displayed.

Zero calibration should also be performed if the flowmeter indicates some flow when there is no actual flow at the moment.

2.5.5 Protection switch

The flowmeter has a protection switch block (see Figure 2.15), which protects the flowmeter's calibration coefficients from unauthorized access. The protection switch block is located at the front side of display board to the right from the display. The protection switch block contains 8 switches.

To access the protection switch block it is necessary to remove the sealing wire or the sticker from the front cover of the transmitter, then remove the front cover.

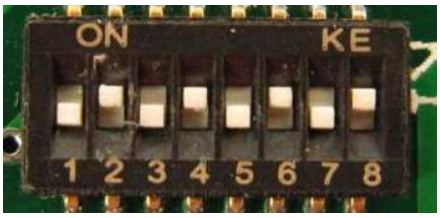

Figure 2.15 Protection switch block in default positions

At factory switches 2, 4, 6, 8 are set to ON (see Figure 2.15). In this position, the calibration parameters of the flowmeter cannot be changed, entering the menu section 5 "Calibration" and section 7 "System Para" is not available. Such a state of the switches is necessary to change of some Modbus registers through digital interface, such as the Modbus register map version or display language (see ***Appendices D and E***).

If any of switches 1-8 is set to ON, the entrance to the "Calibration" and "System Para" sections will also be impossible.

To enter the "Calibration" and "System Para" sections and change or just see the calibration coefficients it is necessary to set all the switches to OFF positions (see Figure 2.16).

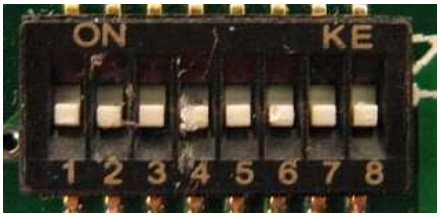

Figure 2.16 Protection switch block in OFF positions

2.5.6 Maintenance

The flowmeter put into operation does not require special maintenance other than periodic inspection to verify the following:

- Compliance with the working conditions;
- Whether the voltage and the other parameters of the power supply conform to the requirements of parameter 1.3.4 “Power supply”;
- Visibility of the information on the nameplates and other labels;
- Cleanness of the exterior surfaces of the flowmeter;
- Tightness of connections of the flowmeter to the pipeline;
- No damage to the flowmeters parts is visible.

Examination period for the flowmeter depends on operation conditions and defined by the maintenance organization in agreement with the operating organization.

In case of the flowmeter’s failure it is necessary to follow the instructions of the paragraph 2.5.7 “Troubleshooting”.

CAUTION!

Working in inappropriate operating conditions may lead to failure of the flowmeter or increase of the measuring error.

2.5.7 Troubleshooting

Possible faults, their probable reasons and repairing ways are presented in Table 2.8.

Table 2.8 - Troubleshooting

Fault	*Probable reason*	*Repairing way*
1 When the flowmeter is powered there is no indication on display nor any signal on the flowmeter’s outputs	Wrong connection of the power wires to the flowmeter.	Check the power cable connection according to the wiring diagram in ***Appendix C***.
	Power wires break.	Check the power wires and replace them if needed.
	Power supply voltage does not meet the requirements of this manual.	Check the power supply voltage and set its value in accordance with the requirements of this manual.
2 When the flowmeter is powered the measured parameters are displayed correctly but there are no signals on the flowmeter’s outputs	Wrong connection of the output wires to the flowmeter or secondary devices.	Check the output wires connection according to the wiring diagrams in ***Appendix C***. Check the computer’s port used to connect the flowmeter to the computer through digital interface. Make sure that the same port number is set in the “Emis-Integrator” settings.
3 When there is a certain actual flow the flowmeter shows zero flow rate on the outputs	The actual flow rate is less than the lower limit of the measuring range for this size of the flowmeter.	Fully open the valves to set the flow rate within the measuring flow range.
	The actual flow rate is less than the low flow cutoff value set in the menu.	Decrease the low flow cutoff value to be less than the actual flow rate.

Fault	Probable reason	Repairing way
4 When there is no actual flow the flowmeter indicates a certain flow	Deviation of the zero point because of temperature and pressure deviation from temperature and pressure values on previous zero calibration.	Perform zero calibration in accordance with the paragraph 2.5.4 “Zero point adjustment”.
5 In the menu it is not possible to enter the “Calibration” and “System Para” sections	At least one of the switches of the protection switch block is set to the ON position.	Set all the switches to OFF positions (see Figure 2.15) for the time needed to perform changes in those sections.

A special LED indicator is provided for indication in case of some faults of the flowmeter. LED is located over the display and its color and lighting period depends on the kind of the flowmeter’s fault according to Table 2.9.

Table 2.9 – LED diagnostics

Lighting period	Fault
Lights continuously right after power-up	Self-diagnostics test failed
Lights continuously some time later after power-up	Wrong zero calibration
Flashing. The color is red	Malfunction of the flowmeter
Flashing. Lights within 3/4 of the period, dark within 1/4 of the period	Flow rate is less than the lower limit of the flow range for this size of the flowmeter

To determine a fault in the sensor part of the flowmeter it is necessary to check the resistance of the coils first. Resistance value should be in the ranges specified in Table 2.10.

Table 2.10 – Coils diagnostics

Circuit element	Wire color	Contact number	Resistance range, Ohm
Left coil	Brown, red	1, 2	60 – 75
Right coil	Orange, yellow	3, 4	60 – 75
Drive coil	Blue, green	5, 6	6 – 30
Temperature sensor	Gray, white	7, 8	75 – 175
Temperature sensor	Gray, black	7, 9	75 – 175

Reclamation act appearance and procedure of returning the faulty flowmeter and its warranty repair are descripted in the passport of the flowmeter.

3 TRANSPORTATION AND STORAGE

3.1 Transportation

While transportation of the flowmeter it is recommended to follow these recommendations:

- The flowmeter should be transported in a transport container, which should protect the flowmeter from mechanical damage;
- It is recommended to lay a waterproof paper inside the transport container;
- Transportation should be performed at ambient temperatures from -40 to +70 ℃, with relative humidity up to 100% non-co ndensing at 35 ℃;
- Protection against atmospheric precipitation must be provided;
- Flowmeters can be transported by all kinds of roofed transport, including air transport in heated hermetic compartments in accordance with the rules in force for this type of transport;
- The requirements in the package handling marks should be fulfilled;
- Method of stacking the boxes on the transport vehicle must prevent their movement;
- The boxes must not be the object to sharp blows while loading / unloading;
- Period of stay in the transportation conditions must be not more than 3 months;
- After transportation at a temperature below 0 ℃ co ntainer with the flowmeter should be unpacked at least 12 hours after its storage in a warm room.

When the flowmeter is transported out of package it is necessary to follow recommendations given in Figure 3.1.

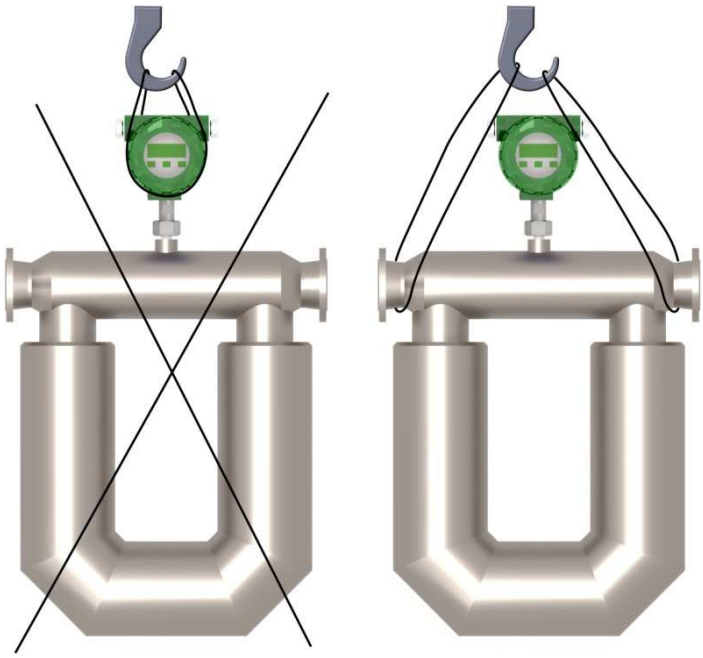

Figure 3.1 Out of package transportation rules

3.2 Storage

Flowmeters can be stored in unheated rooms with air temperature of -20 to +70 ℃ and relative humidity up to 95% (non-condens ing at 25 ℃).

Flowmeters can be stored in a transport boxes stacking of up to 3 boxes in height and also without package. For the long-term storage it is recommended to use the manufacturer's package.

3.3 Utilization

Flowmeters are free of harmful substances and components that are hazardous to human health and the environment during and after the life of the flowmeter and after utilization.

Utilization of the flowmeter is performed separately for groups of materials: plastic parts, metal parts and fastening parts.

4 VERIFICATION

Verification of the flowmeters is performed in accordance with the document "Instructions GSI. Coriolis Mass Flowmeter "EMIS-MASS 260". Verification procedure."

APPENDIX A

Outline dimensions and weight

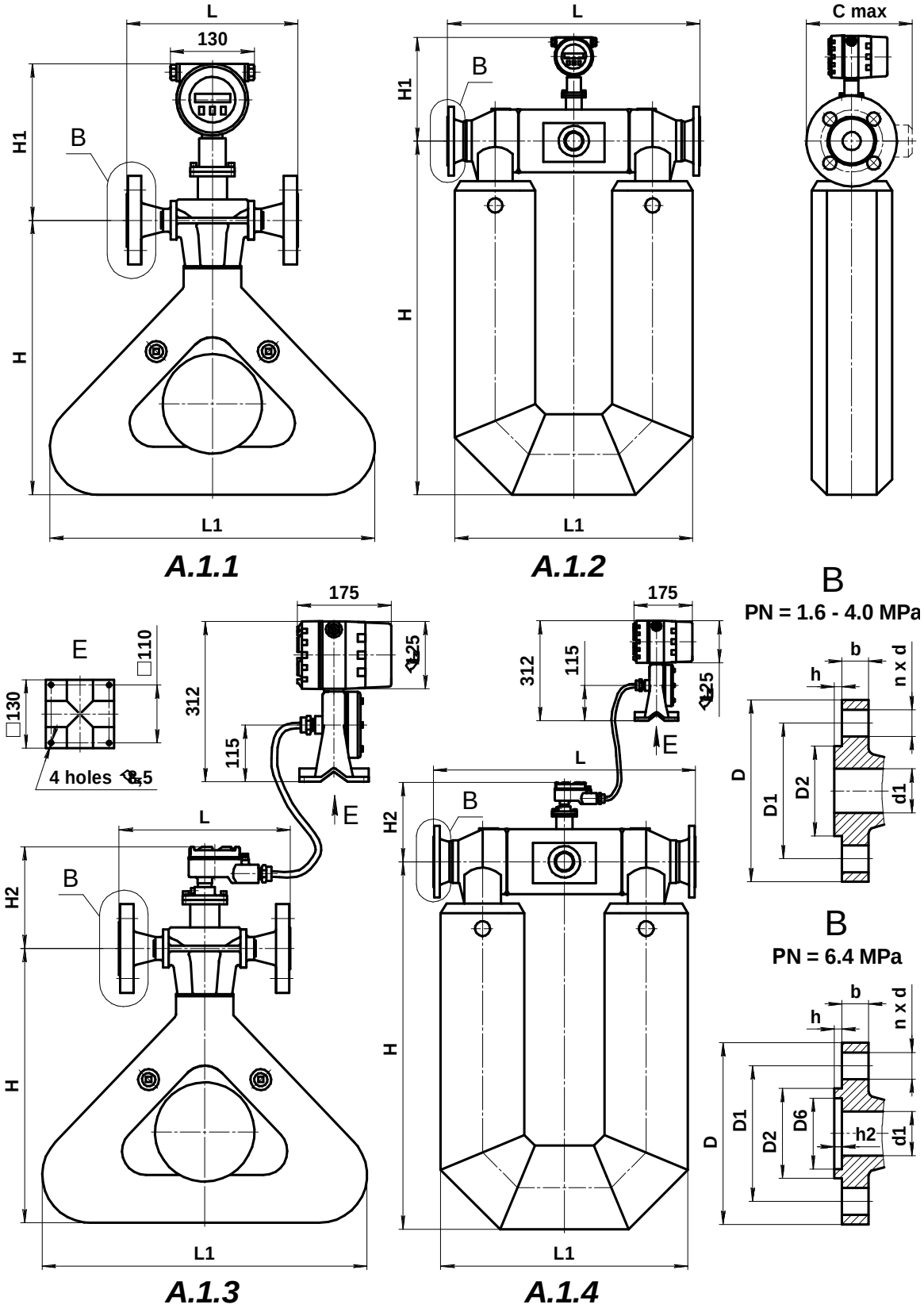

Figure A.1 Outline dimensions

Integral type – Figure A.1.1., A.1.2
Separate type – Figure A.1.3, A.1.4

Table A.1 – Outline dimensions and weight

DN, mm	Figure	L, mm		L_1, mm	H, mm	H_1, mm	H_2, mm	C max, mm *	Weight, kg	
		1.6-4.0 MPa	6.4 MPa						A.1.1, A.1.2	A.1. 3, A.1.4
010	A.1.1; A.1.3	150	170	350	290	260	130	90	11	14
015	A.1.1; A.1.3	180	192	350	290	260	108	95	11	14
025	A.1.1; A.1.3	200	248	450	400	290	188	115	15	18
040	A.1.2; A.1.4	520	547	470	660	280	182	150	30	33
050	A.1.2; A.1.4	558	588	550	750	290	198	165	35	38
080	A.1.2; A.1.4	780	808	710	1040	320	227	205	80	83
100	A.1.2; A.1.4	920	946	860	1290	350	290	390	185	188
150	A.1.2; A.1.4	1100	–	1050	1600	380	280	440	320	323
200	A.1.2; A.1.4	1380	–	1160	1740	420	335	535	625	628

** Overall width of the body, excluding transmitter*

Table A.2 – Flowmeter flange dimensions

DN, mm	PN, MPa	d1, mm	D6, mm	D2, mm	D1, mm	D, mm	b, mm	h, mm	h2, mm	n	d, mm
010	1.6; 2.5; 4	10	–	40	60	90	12	2	–	4	14
	6.4	8	35	41	70	100	16	4	3	4	14
015	1.6; 2.5; 4	15	–	46	65	95	12	2	–	4	14
	6.4	11.6	40	46	75	105	16	4	3	4	14
025	1.6; 2.5; 4	27.3	–	65	85	115	13	3	–	4	14
	6.4	24.8	58	65	100	140	20	4	3	4	18
040	1.6; 2.5; 4	41.1	–	85	110	150	13	3	–	4	18
	6.4	37	76	84	125	170	22	4	3	4	22
050	1.6; 2.5; 4	52.3	–	99	125	165	18	2	–	4	18
	6.4	47	88	99	135	180	22	4	3	4	22
080	1.6; 2.5; 4	79.5	–	132	160	200	20	2	–	8	18
	6.4	77	121	132	170	215	24	4	3	8	22
100	1.6; 2.5; 4	101.7	–	156	190	235	21	3	–	8	22
	6.4	94	150	156	200	250	25.5	4.5	3.5	8	26
150	1.6; 2.5; 4	154	–	211	250	300	26	2	–	8	26
	6.4	142	204	211	280	345	31.5	4.5	3.5	8	33
200	1.6; 2.5; 4	200	–	285	320	375	35	3	–	12	30
	6.4	198	260	284	345	415	37.5	4.5	3.5	12	36

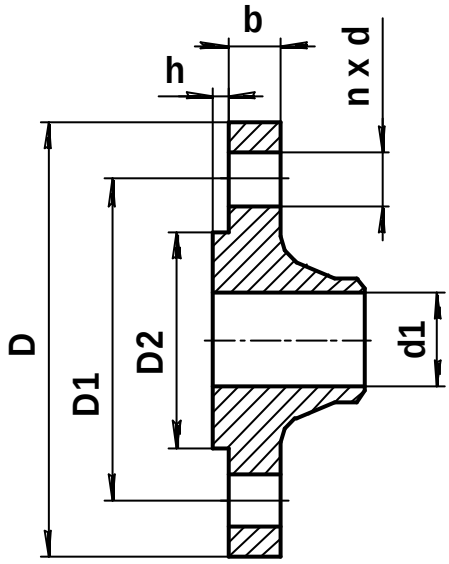

Figure A.2 Outline dimensions of connection kit flanges

Table A.3 – Connection kit flange dimensions and weight

DN, mm	PN, MPa	d1, mm	D2, mm	D1, mm	D, mm	b, mm	h, mm	n	d, mm	Weight, kg
010	1.6; 2.5; 4	10	40	60	90	12	2	4	14	0.7
	6.4	8	34	70	100	16	4	4	14	1.0
015	1.6; 2.5; 4	15	46	65	95	12	2	4	14	0.8
	6.4	11.6	39	75	105	16	4	4	14	1.1
025	1.6; 2.5; 4	27.3	65	85	115	13	3	4	14	1.2
	6.4	24.8	57	100	140	20	4	4	18	2.3
040	1.6; 2.5; 4	41.1	85	110	150	13	3	4	18	2.1
	6.4	37	75	125	170	22	4	4	22	3.7
050	1.6; 2.5; 4	52.3	99	125	165	18	2	4	18	2.8
	6.4	47	87	135	180	22	4	4	22	4.6
080	1.6; 2.5; 4	79.5	132	160	200	20	2	8	18	4.8
	6.4	77	120	170	215	24	4	8	22	7.2
100	1.6; 2.5; 4	101.7	156	190	235	21	3	8	22	7.0
	6.4	94	149	200	250	25.5	4.5	8	26	10.7
150	1.6; 2.5; 4	154	211	250	300	26	2	8	26	13.2
	6.4	142	203	280	345	31.5	4.5	8	33	25.4
200	1.6; 2.5; 4	200	285	320	375	35	3	12	30	24.0
	6.4	198	259	345	415	37.5	4.5	12	36	38.5

APPENDIX B

Working with "EMIS-Integrator" software

«EMIS-Integrator» software is designed to query and configure flowmeters through digital interface with a personal computer (hereinafter – the PC).

To install «EMIS-Integrator» it is necessary to run «EMISSoftware_X_X_X.exe» file, where X.X.X means the version of the software. When installation started follow the instructions of the setup wizard.

On the first start of the program it will automatically start searching the flowmeters connected to the PC. In the log area a message about searching start will appear. In the "Device list" the addresses and descriptions of all found devices will be displayed. If no devices were found, it is recommended to check the connection of the flowmeter to the PC, power supply and also check the program's settings. To change the settings press button «**Настройки**» (**Settings**) on the toolbar. In the appeared window specify the number of COM port used and the baud rate the same as in flowmeter's settings. (Default value is 9600 bit/s), then click «ОК».

To work with one of the found flowmeters select it in the device list. Double click on its address and in the main area of the program the following pages (tabs) will appear: **«Мониторинг»**, **«Калибровка»**, «**Выходные сигналы»**, **«Аппаратный мониторинг» «Единицы измерения», «Рабочие параметры», «Расширенные функции», «Связь»**. The active tab is **«Мониторинг»**

Initially the active tab is **«Мониторинг» (Monitoring),** it contains the following parameters: instant mass flow rate («**Мгновенный массовый расход, кг/ч**»), total mass («**Накопленная масса, кг**»), instant volumetric flow rate («**Мгновенный объемный расход, л/ч**»), total volume («**Накопленный объем, л**»), density («**Плотность, г/см^3**») and temperature («**Температура, ºС**») of the measured medium.

Each tab has «**Интервал запросов» (Query period)** field. This is the period of reading displayed data from the flowmeter in the units of µs, default value is 1000 µs.

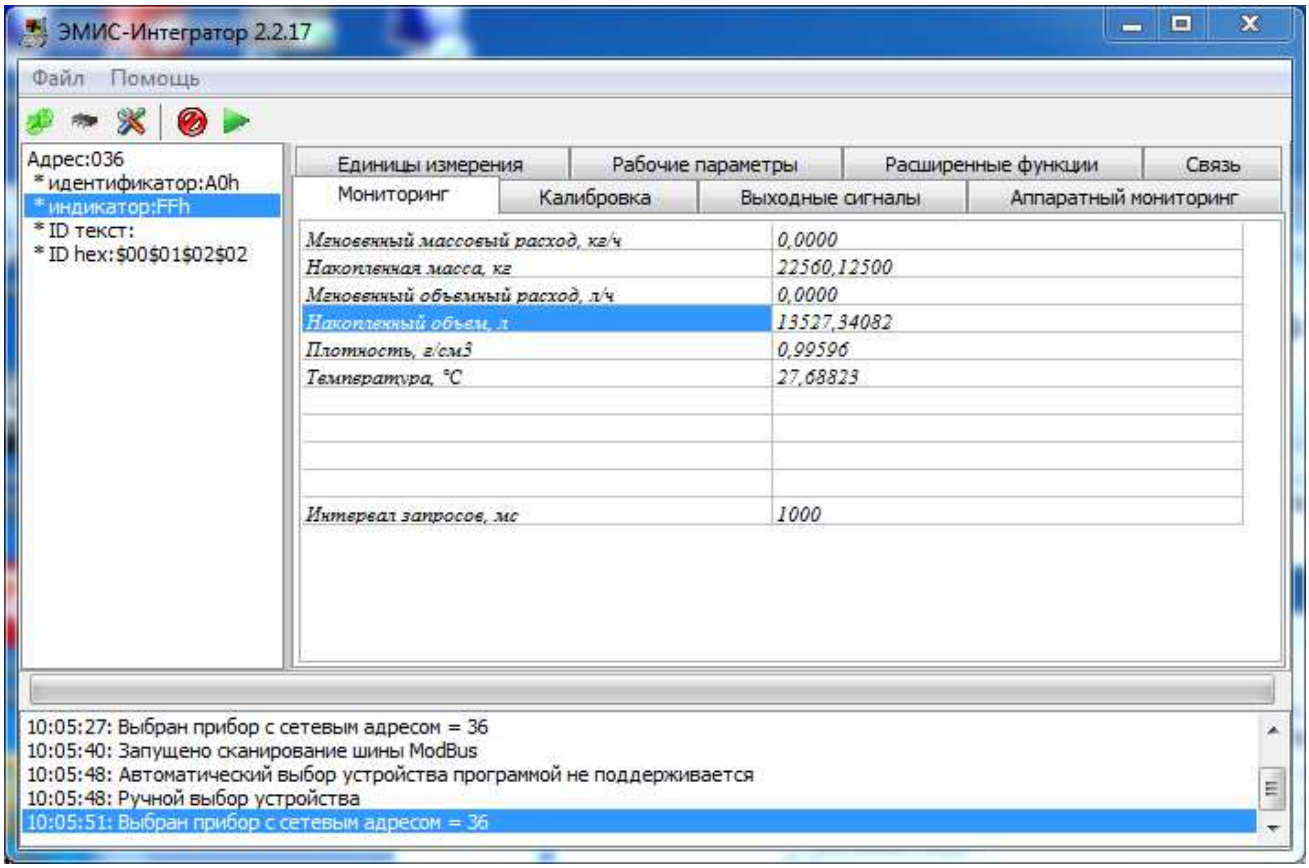

Figure B.1 – «Мониторинг» (Monitoring) tab

On the **«Калибровка» (Calibration)** tab the main calibration parameters are displayed.

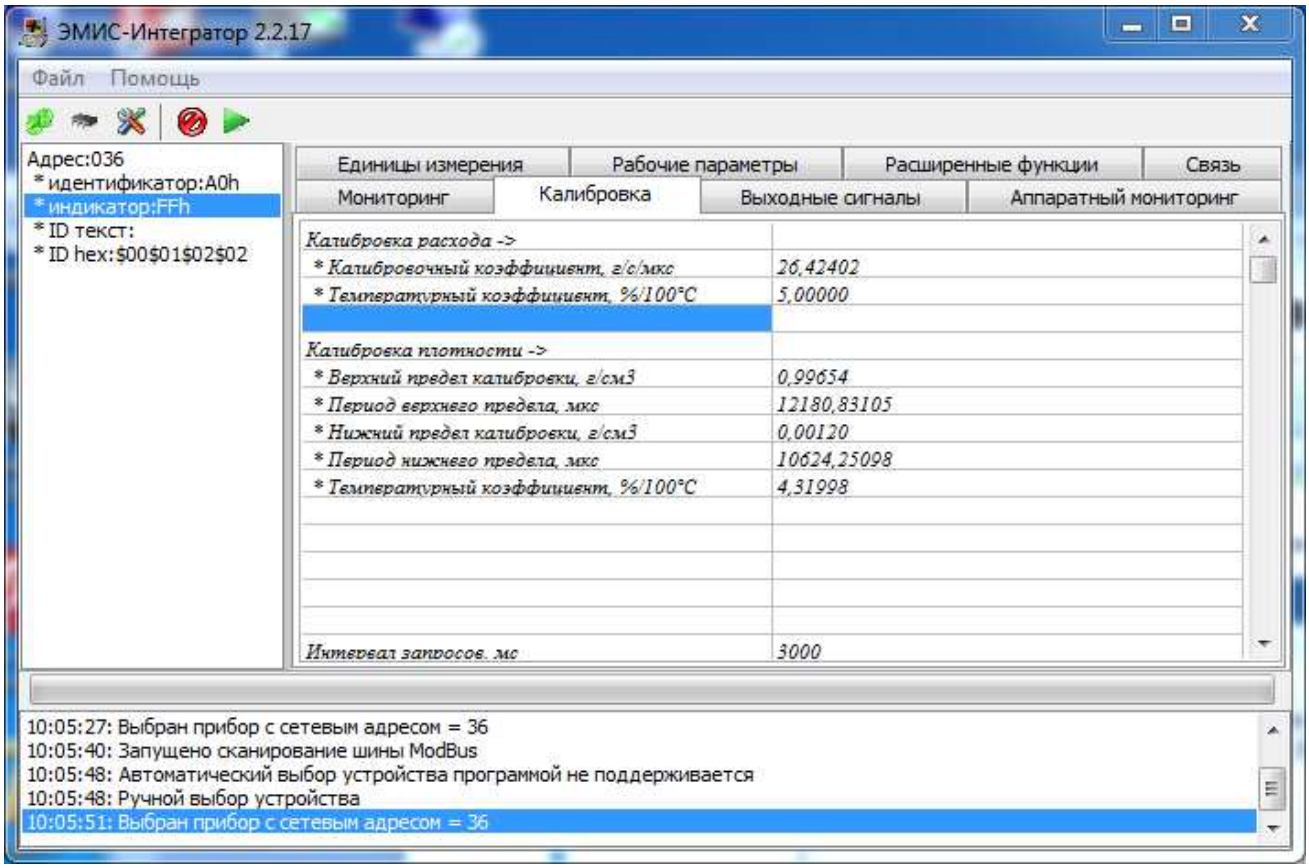

Figure B.2 – «Калибровка» (Calibration) tab

The group of parameters **«Калибровка расхода» (Flow calibration)** contains 2 parameters:

«Калибровочный коэффициент, г/с/мкс» is the flow calibration coefficient **K**, which means the flow rate (in g/s) for 1 µs of time delay between left and right coils signals.

«Температурный коэффициент, %/100℃» sets the temperature correction coefficient for flow rate as percentage of calibration coefficient correction for temperature deviation of 100°C.

The group of parameters **«Калибровка плотности» » (Density calibration)** contains 5 parameters:

«Верхний предел калибровки, г/см^3» - High density value corresponding to the medium of high density (water).

«Период верхнего предела, мкс» - Measuring tubes' oscillation frequency for the medium of high density (water).

«Нижний предел калибровки, г/см^3» - Low density value corresponding to the medium of low density (air).

«Период нижнего предела, мкс» - Measuring tubes oscillation frequency for the medium of low density (air).

«Температурный коэффициент, %/100℃» - Temperature correction coefficient for density as percentage of measured density correction for temperature deviation of 100°C.

On the **«Выходные сигналы» (Output signals)** tab parameters of the outputs are displayed.

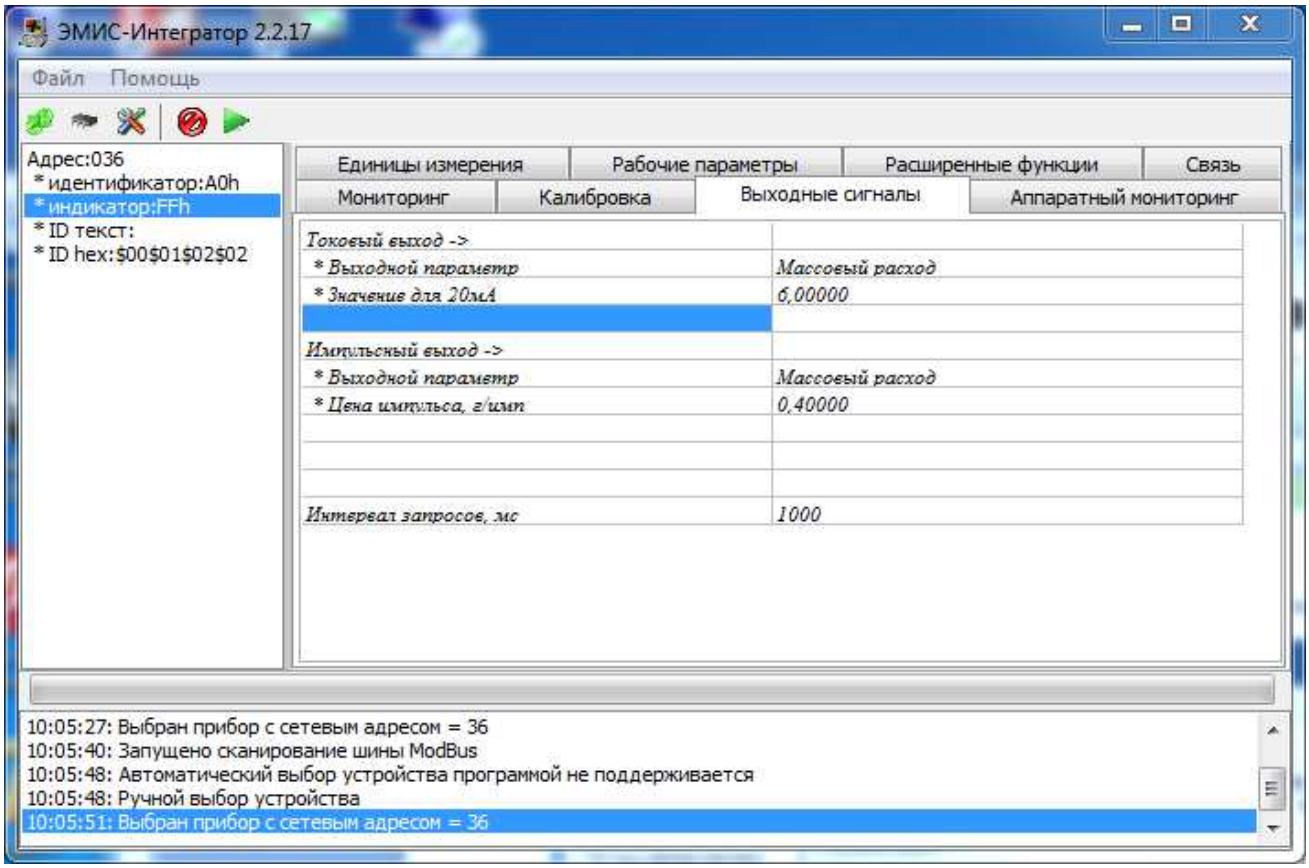

Figure B.3 – «Выходные сигналы» (Output signals) tab

In the group of parameters **«Токовый выход» (Current output)** you can choose the measured parameter for the current output: **«Массовый расход» (Mass flow rate), «Объемный расход» (Volumetric flow rate), «Плотность» (Density)**, and also its value relating to maximum current of 20 mA.

In the group of parameters **« Импульсный выход» (Pulse output)** you can choose the measured parameter for the current output: **«Массовый расход» (Mass flow rate), «Объемный расход» (Volumetric flow rate), «Плотность» (Density)**, and also its value relating to 1 pulse on the pulse output.

«Аппаратный мониторинг» (Hardware monitoring) tab displays the state of the flowmeter and its hardware parameters, such as measuring tubes oscillation frequency, voltage on the left and right coils, drive coil load, the values of signals on current and pulse outputs.

«**Карта регистров Modbus» (Modbus register map)** switches the flowmeter to «ProLink» or «EMIS» Modbus register map.

CAUTION!
After switching to «ProLink» register map «EMIS-Integrator» software will stop reading and displaying parameters of the flowmeter. But «**Карта регистров Modbus**» field will still be available to change. If the flowmeter was configured to use «ProLink» register map, then on the start of the program a confirmation window will appear with the request to switch to the “EMIS” version of Modbus registers for «EMIS-Integrator» to work normally. Press «OK» to switch to «EMIS» version, or «Cancel» to keep the «ProLink» version of Modbus registers.

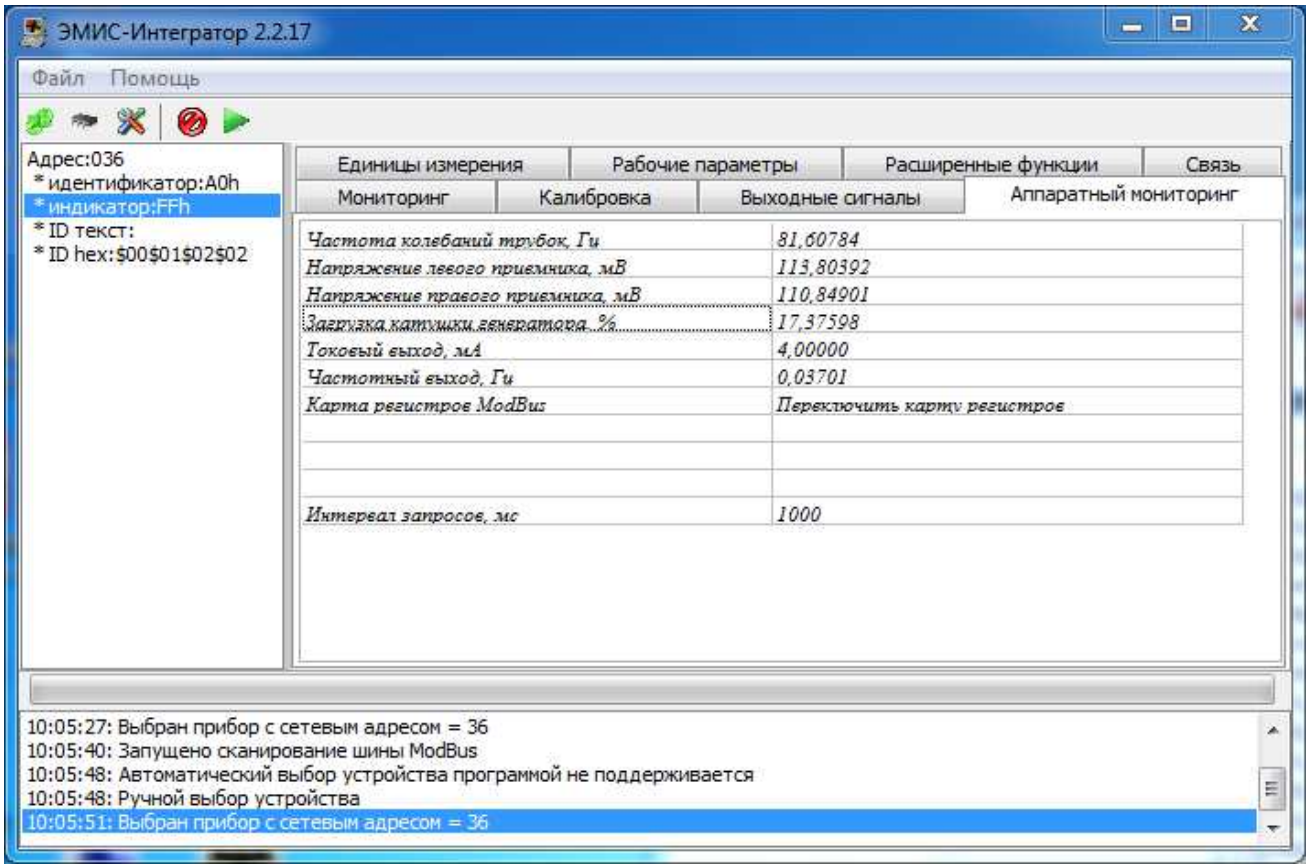

Figure B.4 – «Аппаратный мониторинг» (Hardware monitoring) tab

On the **«Единицы измерения» (Units)** tab it is possible to change the units of measured parameters which are displayed in the menu items 1, 2, 3.

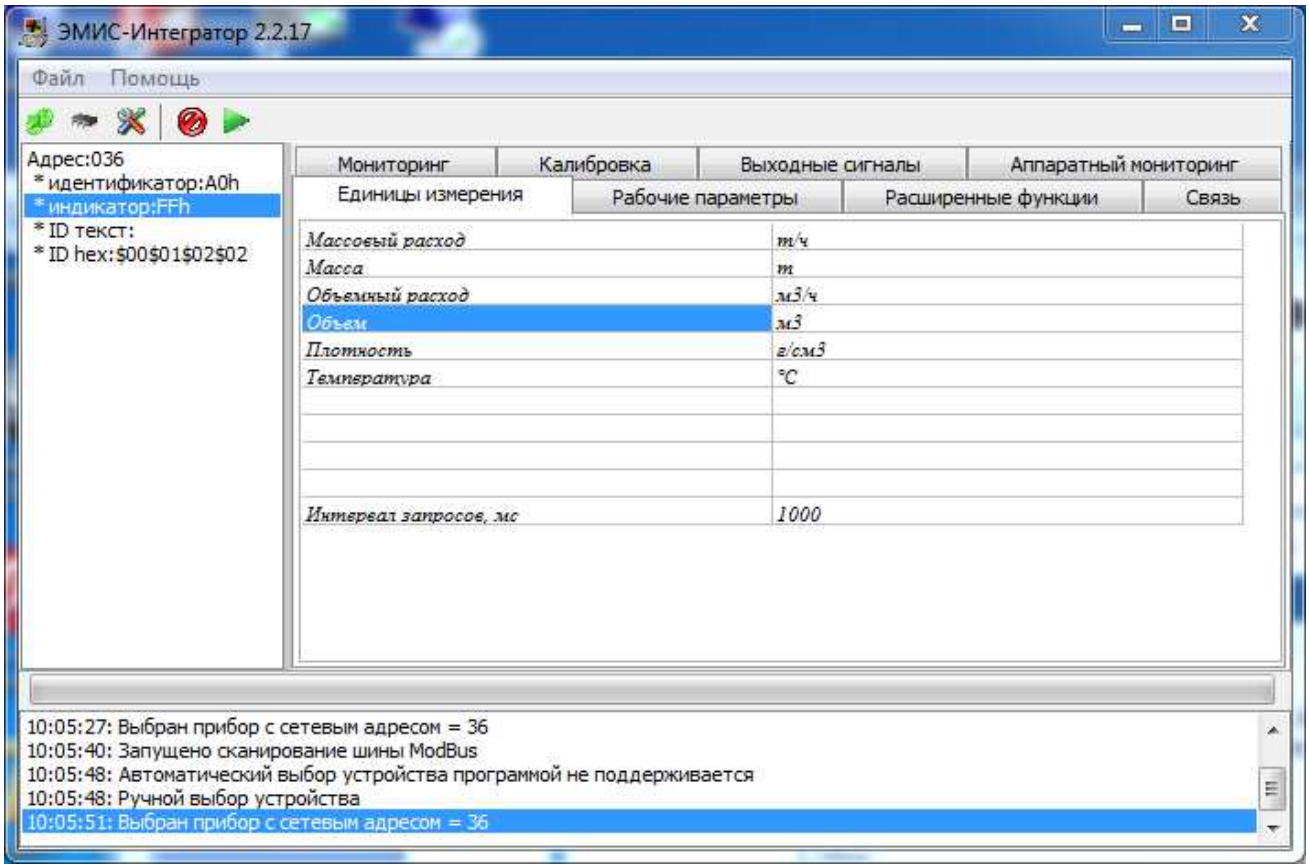

Figure B.5 – «Единицы измерения» (Units) tab

On the **«Рабочие параметры» (Working parameters)** tab it is possible to set the following parameters:

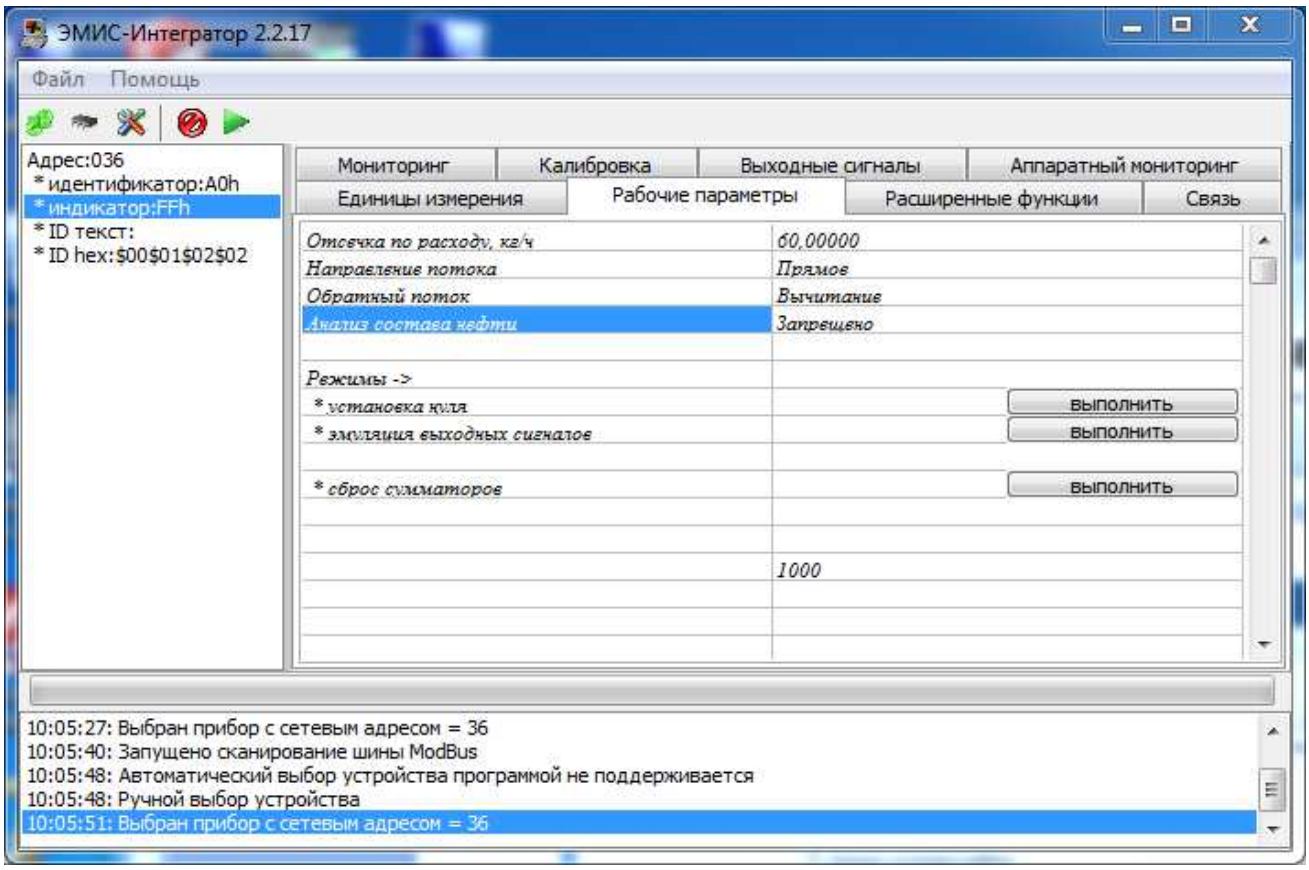

Figure B.6 – «Рабочие параметры» (Working parameters) tab

"Отсечка по расходу, кг/ч" – Low flow cutoff (see Menu item 17) in the units of kg/h.

«Направление потока» – Flow direction options (see Menu item 19). If **«прямое» (SIG)** is chosen then only direct flow will be accumulated (direction corresponding to the arrow on the sensor body). If **«реверсивное» (BID)** is chosen then flow will be counted on both direct and reverse directions.

«Обратный поток» – Reverse flow counting options (see Menu item 20). If **«Суммирование» (INC)** is chosen then the flow will be added to mass and volume totalizers. If **«Вычитание» (DEC)** is chosen then the flow will be subtracted from mass and volume totalizers.

«Анализ состава нефти» – Enable/disable Oil-water analyze mode (see Menu item 52).

The parameter group **«Режимы» (Procedures)** allows the user to perform the following procedures:

«Установка нуля» – Zero calibration (see Menu item 16).

«Эмуляция выходных сигналов» – Automatic flow simulation, when the sequence of frequency and current test signals appears on the flowmeter's outputs (see Menu item 44).

«Сброс сумматоров» – Reset totalizers (see Menu item 18).

The **«Расширенные функции» (Extended functions)** tab contains the following parameters:

«Нулевая точка, мкс» – The time delay between left and right coils taken as zero flow rate (see Menu item 16).

«Многоточечная коррекция» – Enable/disable multipoint correction function (see Menu item 81) used for correction of the calibration coefficient in several points of flow rate (time delay) below.

For different values of time delay between left and right signal coils and corresponding mass flow rates D0 - D7 («**Массовый расход в точке X, DX мкс**») the corresponding correction coefficients K0 – K7 («**Коэффициент коррекции в точке X, KX**») are specified. Those coefficients are applied only of Multipoint correction function is enabled.

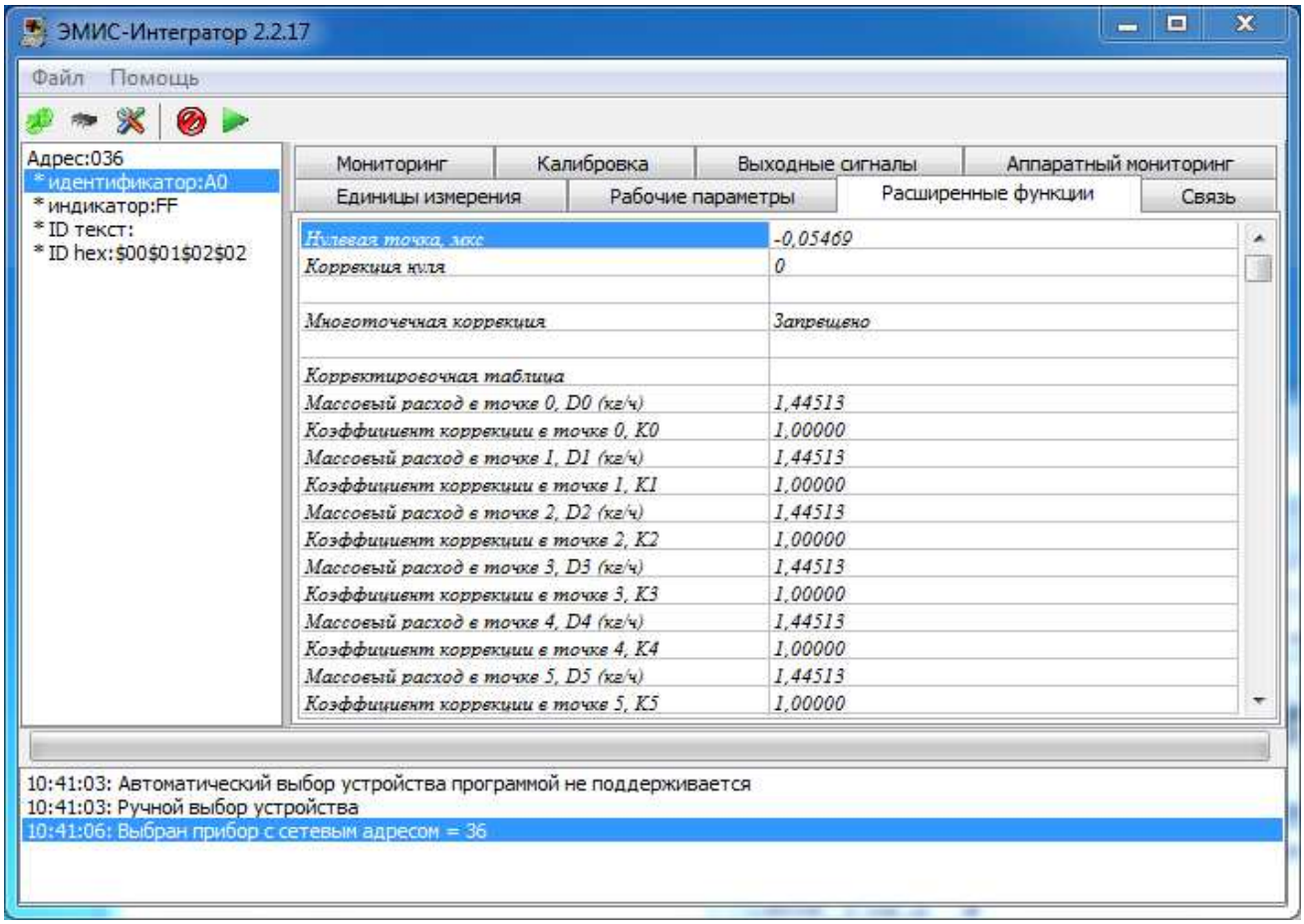

Figure B.7 – «Расширенные функции» (Extended functions) tab

On the **«Связь» (Connection)** tab the following parameters are displayed:

«ModBus адрес» – Address of the flowmeter in Modbus network.

«ModBus скорость, бит/с» – Data transfer baud rate in Modbus network.

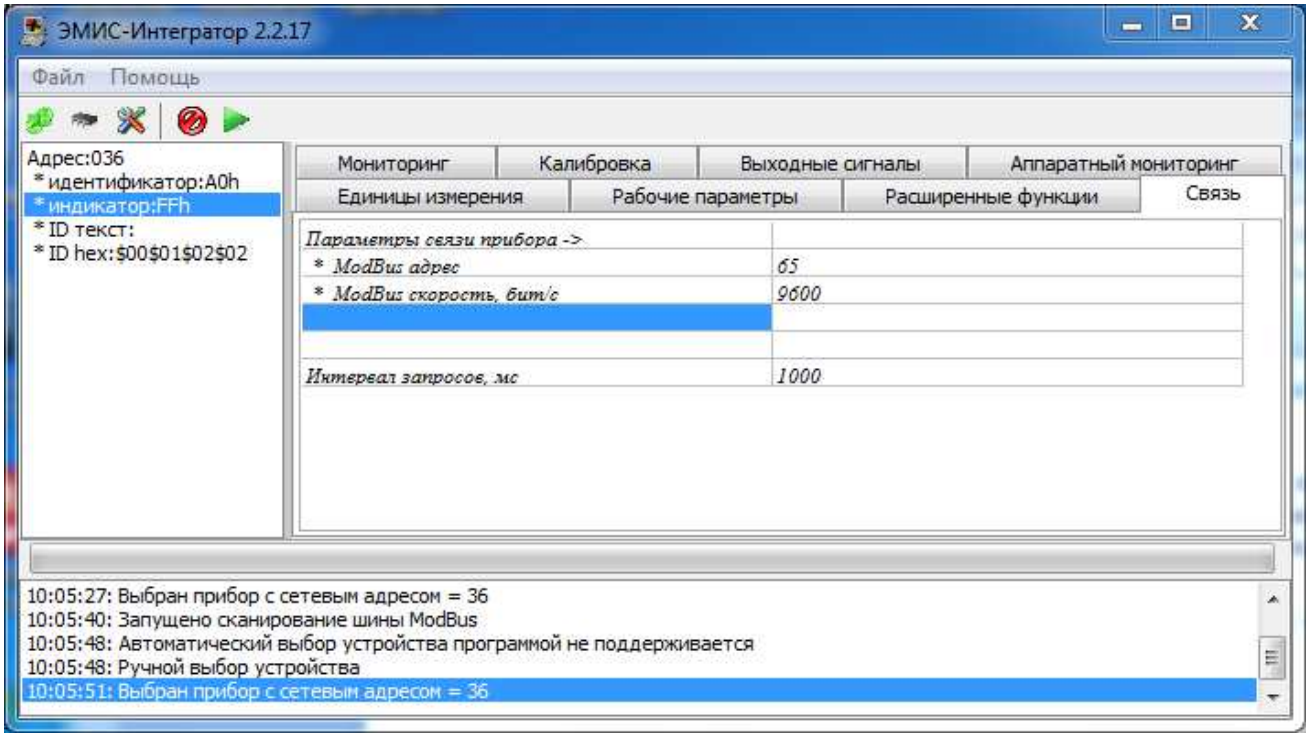

Figure B.8 – «Связь» (Connection) tab

APPENDIX C

Wiring diagrams

Transmitter

Sensor

Line
1
2
3
4
5
6
7
8
9

Line	Function	Color
1	Left signal coil +	Brown
2	Left signal coil -	Red
3	Right signal coil +	Orange
4	Right signal coil -	Yellow
5	Drive coil +	Green
6	Drive coil -	Blue
7	Temperature +	Gray
8	Temperature -	White
9	Temperature compensation	Black

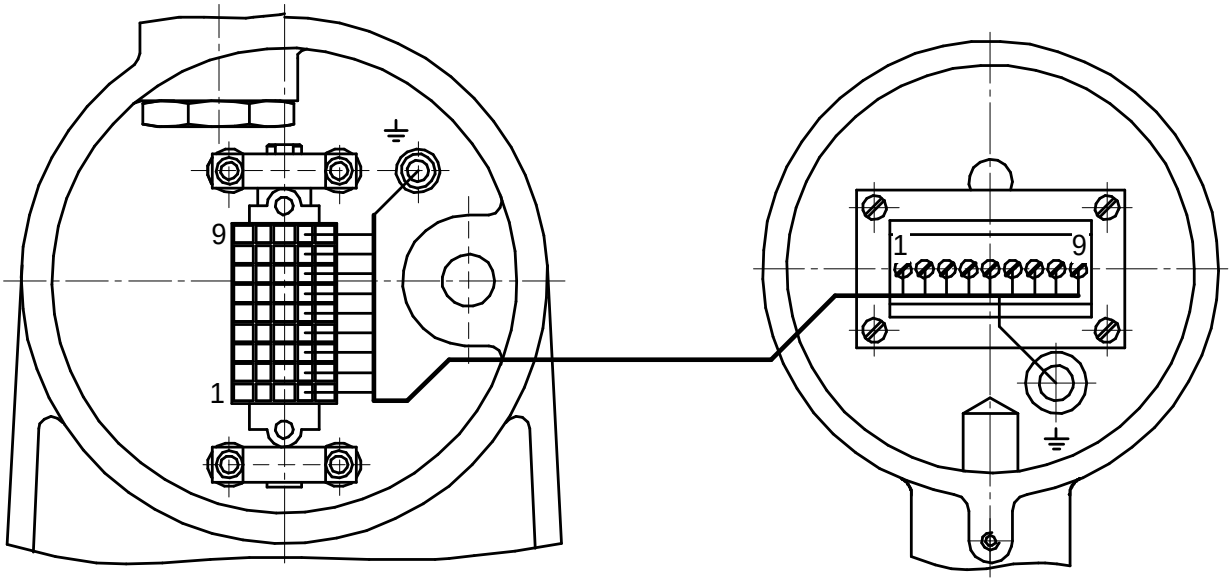

Figure C.1 – Separate type transmitter connection

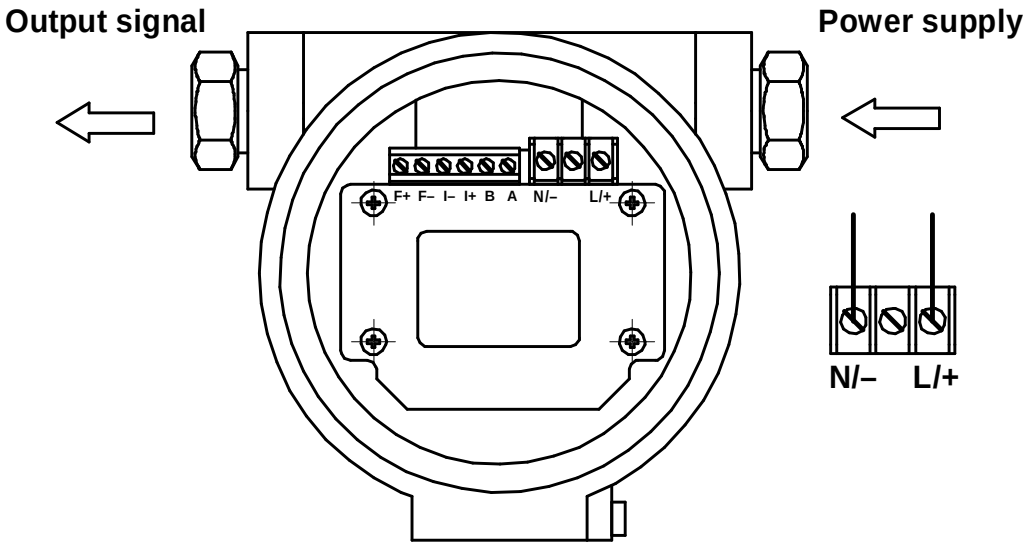

Figure C.2 – Power supply connection

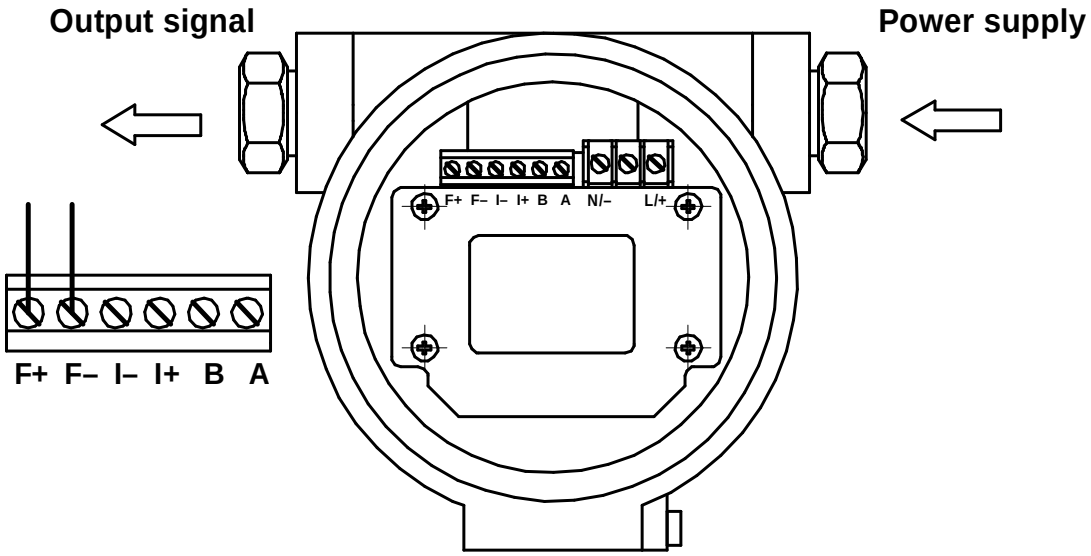

Figure C.3 – Pulse output connection

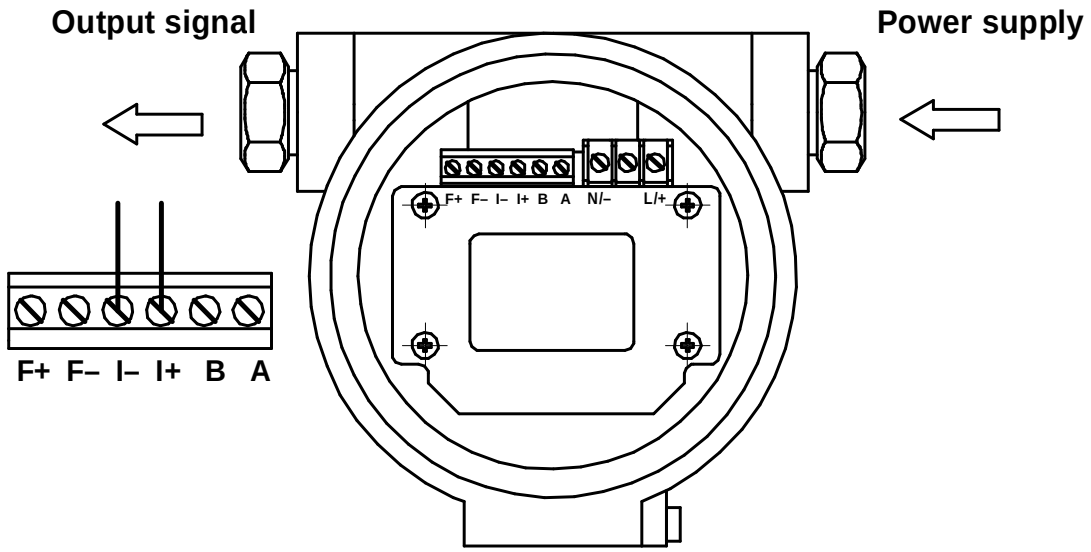

Figure C.4 – Current output connection

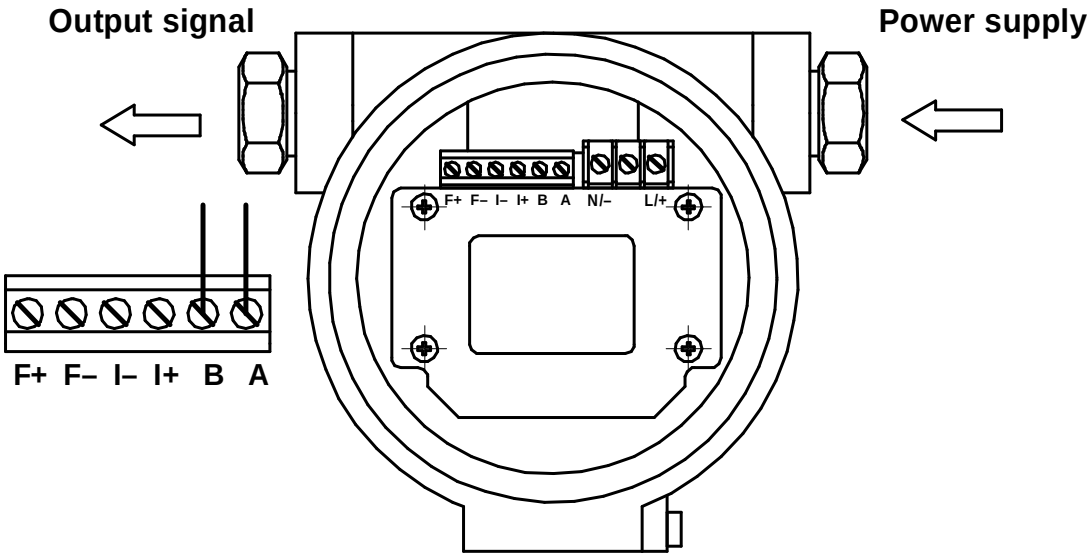

Figure C.5 – Digital output connection

APPENDIX D

Modbus register map version 2.xx (EMIS)

Modbus register map version V2.17

Interface mode	RS-485, asynchronous, half-duplex
Baud rate	1200, 2400, 4800, 9600 bit/s
Data format	1 start bit, 8 data bits, No parity bit and 1 or 2 stop bits (or 1 Odd Parity or Even Parity, and 1 stop bit). Can be set in the Menu items 30, 31. Default data format is 9600-8-N-1
Maximum length of data frame	1 byte address + 253 byte data + 2byte CRC = 256 Bytes

Frame structure:

Function 01: Read Coil Status

Query:

Slave address	Function	Starting address		Coils quantity		CRC	
	01H	00H	08H	00H	08H		

Response:

Slave address	Function	Byte count	Coil status	CRC	
	01H	01H			

Error:

Slave address	Function	Error code	CRC	
	81H	01H		

Exception code:

01H：Function is not supported

02H：Incorrect Starting address or Coils quantity

03H：Coils quantity is out of range of 1 – 200

04H：Failed to read coil

Function 04: Read Input Registers

Query:

Slave address	Function	Starting address		Registers quantity		CRC	
	04H						

Response:

Slave address	Function	Byte count	Data value		CRC	
	04H					

Error:

Slave address	Function	Error code	CRC	
	84H	01H		

Exception code:

01H：Function is not supported

02H：Incorrect Starting address or Registers quantity

03H：Registers quantity is out of range of 0 – 125

04H：Failed to read registers

Function 05: Write Single Coil

Query:

Slave address	Function	Coil address		Data value		CRC	
	05H						

Response:

Slave address	Function	Coil address		Data value		CRC	
	05H						

Error:

Slave address	Function	Error code	CRC	
	85H	01H		

Exception code:

01H：Function is not supported

02H：Incorrect Coil address

03H：Data value is out of range of 0x0000 – 0xFF00

04H：Failed to write single coil

Function 06: Write Single Register

Query:

Slave address	Function	Register address		Data value		CRC	
	06H						

Response:

Slave address	Function	Register address		Data value		CRC	
	06H						

Error:

Slave address	Function	Error code	CRC	
	86H	01H		

Exception code:

01H：Function is not supported

02H：Incorrect Register address

03H：Data value is out of range of 0 – 65535

04H：Failed to write single register

Function 08: Diagnostics (supports only subfunction code 00)

Query:

Slave address	Function	Subfunction		Data value		CRC	
	08H	00H	00H	xxH	xxH		

Response:

Slave address	Function	Subfunction		Data value		CRC	
	08H	00H	00H	xxH	xxH		

Error:

Slave address	Function	Error code	CRC	
	88H	01H		

Exception code:

01H：Function or subfunction is not supported

03H：Incorrect Data value

04H：Failed to diagnose

Function 16: Write Multiple Registers

Query:

Slave address	Function	Starting address		Registers quantity		Byte count	Data value				CRC	
	10H			00H	02H	04H						

Response:

Slave address	Function	Starting address		Registers quantity		CRC	
	10H			00H	02H		

Error:

Slave address	Function	Error code	CRC	
	90H	01H		

Exception code:

01H：Function is not supported

02H：Incorrect Starting address or Registers quantity

03H：Registers quantity (N) is out of range of 1 – 123 or Byte count is not equal to N * 2

04H：Failed to write multiple registers

Function 17: Report Slave ID

Query:

Slave address	Function	CRC	
	11H		

Response:

Slave address	Function	Byte count	Slave ID	Run indicator status	Software version				CRC	
	11H	06H	AOH	FFH						

Error:

Slave address	Function	Error code	CRC	
	91H	01H		

Exception code:

01H：Function or subfunction is not supported

04H：Failed to fetch Slave ID

Minimal query period is 32 µs. Recommended period is 125 µs.

Example of queries:

Read Reverse flow total count mode

Query:

Slave address	Function	Starting address		Coils quantity		CRC	
41H	01H	00H	08H	00H	08H	B2H	CEH

Response:

Slave address	Function	Byte count	Coil status	CRC	
41H	01H	01H	00H	44H	48H

Error:

Slave address	Function	Error code	CRC	
41H	81H	01H	80H	44H

Result: Reverse flow is subtracted from the totalizer values

Reset totalizer (resettable)

Query:

Slave address	Function	Coil address		Data value		CRC	
41H	05H	00H	02H	FFH	00H	23H	3AH

Response:

Slave address	Function	Coil address		Data value		CRC	
41H	05H	00H	02H	FFH	00H	23H	3AH

Error:

Slave address	Function	Error code	CRC	
41H	85H	01H	82H	84H

Perform zero calibration

Query:

Slave address	Function	Coil address		Data value		CRC	
41H	05H	00H	04H	FFH	00H	C3H	3BH

Response:

Slave address	Function	Coil address		Data value		CRC	
41H	05H	00H	04H	FFH	00H	C3H	3BH

Error:

Slave address	Function	Error code	CRC	
41H	85H	01H	82H	84H

Read mass flow rate

Query:

Slave address	Function	Starting address		Registers quantity		CRC	
41H	04H	00H	A7H	00H	02H	CEH	E8H

Response:

Slave address	Function	Byte count	Data value		CRC	
41H	04H	04H	43H	B4H	74H	D0H

Error:

Slave address	Function	Error code	CRC	
41H	84H	01H	83H	14H

Result: mass flow rate is 360.9126 kg/s

Write mass unit of kg

Query:

Slave address	Function	Register address		Data value		CRC	
41H	06H	00H	15H	00H	01H	57H	0EH

Response:

Slave address	Function	Register address		Data value		CRC	
41H	06H	00H	15H	00H	01H	57H	0EH

Error:

Slave address	Function	Error code	CRC	
41H	86H	01H	82H	74H

Write calibration coefficient K = 1100 g/s/µs

Query:

Slave address	Function	Starting address		Registers quantity		Byte count	Data value				CRC	
41H	10H	00H	63H	00H	02H	04H	44H	89H	80H	00H	44H	89H

Response:

Slave address	Function	Starting address		Registers quantity		CRC	
41H	10H	00H	63H	00H	02H	BFH	16H

Error:

Slave address	Function	Error code	CRC	
41H	90H	01H	8CH	14H

General information

The addresses in the tables below are decimal; the starting address is 1.

For example, address 127 corresponds to hexadecimal address 0x007EH (126 decimal).

Read/Write mode: WO – write only; RO – read only; RW – read and write

Coils

Functions: Read – 01, Write – 05

Read: 0 – Off ; 1 – On

Write: 0x0000 – Off , 0xFF00 – On

Address	Mode	Description	Menu item *
0001	WO	Output emulation 1 – Start output emulation	12
0003	WO	Reset totalizer (resettable) 1 – Reset totalizer	18
0004	WO	Reset totalizer (inventory) ** 1 – Reset totalizer	–
0005	WO	Zero calibration 1 – Start zero calibration	16
0009	RW	Reverse flow total count mode 0 – Subtract from the totalizer (default) 1 – Add to the totalizer	20
0011	RW	Oil-water analyze (pure oil counting) 0 – Off (default) 1 – On	52
0013	RW	Multipoint correction 0 – Off 1 – On	81
0082	RW	Pressure compensation 0 – Off (default) 1 – On	39

* For Menu items refer to display menu structure in Figure 2.14 and menu items description in Table 2.7.

** To write in registers the switches 2-4-6-8 must be in ON position.

16-bit registers – integer values

2 bytes, high byte first

Functions: Read – 04, Write – 06

Address	Mode	Description	Menu item *
0002	RW	Menu language ** 1 – English 2 – Russian (default)	80
0003	RW	Register map version ** 1 – EMIS (default) 2 – ProLink	–
0012	RW	Current output 0 – Mass flow rate (default) 1 – Volumetric flow rate 2 – Density	27
0013	RW	Modbus Baud rate 0 – 9600 bit/s (default) 1 – 4800 bit/s 2 – 2400 bit/s 3 – 1200 bit/s	29
0014	RW	Pulse output 0 – Mass flow rate (default) 1 – Volumetric flow rate 2 – Density	25

Address	Mode	Description	Menu item *
0015	RW	Zero correction	67
0016	RW	Reserved ***	
0017	RW	Flow direction 0 – Single direction (default) 1 – Bidirectional	19
0018	RW	Mass flow rate unit 0 – g/s 1 – kg/s 2 – kg/min 3 – t/day 4 – kg/h (default) 5 – t/h	33
0019	RW	Density unit 0 – g/cm^3 (default) 1 – kg/L 2 – kg/m^3	36
0020	RW	Temperature unit 0 – °C (default) 0 – F	37
0021	RW	Volumetric flow rate unit 0 – mL/s 1 – L/s 2 – L/min 3 – m^3/day 4 – L/h 5 – m^3/h (default)	35
0022	RW	Mass total unit 0 – g 1 – kg 2 – t (default)	32
0023	RW	Volume total unit 0 – mL 1 – L 2 – m^3 (default)	34
0024	RW	Modbus slave address	28
0257	RO	Calculated pressure from external pressure sensor (Bar)	–
0267	RW	Coefficient of pressure compensation for flow (% / PSI)	40
0269	RW	Coefficient of pressure compensation for density (% / PSI) ***	–
0271	RW	Flow calibration pressure (Bar)	–
0273	RW	Pressure relating to 4 mA (Bar) ***	–
0275	RW	Pressure relating to 20 mA (Bar) ***	–
0451	RW	Input external pressure (Bar)	41
0521	RW	Bytes sequence in floating point 32-bit registers 0 – 0-1-2-3 (default) 1 – 2-3-0-1 2 – 1-0-3-2 3 – 3-2-1-0	75

* For Menu items refer to display menu structure in Figure 2.14 and menu items description in Table 2.7.

** To write in registers the switches 2-4-6-8 must be in ON position.

*** Reserved for future modifications.

32-bit registers – single precision floating point values complied with IEEE 754 format

4 bytes, high bytes first

Functions: Read – 04, Write – 16

For example, value "-1.5" corresponds to "0xBF 0xC0 0x00 0x00" in the order from low to high address in memory.

Address	Mode	Description	Menu item *
0100 0101	RW	Calibration coefficient (g/s/µs)	60
0102 0103	RW	Temperature correction coefficient for flow (% / 100ºC)	61
0104 0105	RW	High density for density calibration (g/cm^3)	62
0106 0107	RW	Period for high density (µs)	63
0108 0109	RW	Low density for density calibration (g/cm^3)	64
0110 0111	RW	Period for low density (µs)	65
0112 0113	RW	Temperature correction coefficient for density (% / 100ºC)	66
0114 0115	RW	Pulse weight	24
0116 0117	RW	Value relating to 20 mA	26
0118 0119	RW	Low flow cutoff (kg/h)	17
0120 0121	RW	Zero point (µs)	16
0122 0123	RW	Density of pure oil under standard conditions (g/cm^3)	53
0124 0125	RW	Density of pure water under standard conditions (g/cm^3)	54
0126 0127	RW	Flow compensation by percentage of gas in the oil-water	55
0128 0129	RW	Flow compensation by percentage of pure water in the oil-water	56 ***
0130 0131	RW	Correction coefficient of the temperature (for simulation mode)	76
0132 0133	RW	Zero temperature (for simulation mode)	77
0134 0135	RW	Correction coefficient of the density (for simulation mode)	78
0136 0137	RW	Zero density (for simulation mode)	79
0138 0139	RW	Time delay for point 0, D0 (µs)	84
0140 0141	RW	Time delay for point 1, D1 (µs)	
0142 0143	RW	Time delay for point 2, D2 (µs)	
0144 0145	RW	Time delay for point 3, D3 (µs)	
0146 0147	RW	Time delay for point 4, D4 (µs)	
0148 0149	RW	Time delay for point 5, D5 (µs)	
0150 0151	RW	Time delay for point 6, D6 (µs)	
0152 0153	RW	Time delay for point 7, D7 (µs)	
0154 0155	RW	Correction coefficient for point 0, K0	85
0156 0157	RW	Correction coefficient for point 1, K1	
0158 0159	RW	Correction coefficient for point 2, K2	
0160 0161	RW	Correction coefficient for point 3, K3	
0162 0163	RW	Correction coefficient for point 4, K4	
0164 0165	RW	Correction coefficient for point 5, K5	
0166 0167	RW	Correction coefficient for point 6, K6	

Address	Mode	Description	Menu item *
0168 0169	RO	Mass flow rate (kg/h)	1
0170 0171	RO	Density (g/cm^3)	3
0172 0173	RO	Temperature (°C)	3
0174 0175	RO	Volumetric flow rate (L/s)	2
0176 0177	RO	Mass total (kg)	1
0178 0179	RO	Volume total (L)	2
0180 0181	RO	Current value on the current output (mA)	71
0182 0183	RO	Frequency of the signal on the pulse output (Hz)	71
0184 0185	RO	Measuring tubes oscillation frequency (Hz)	68
0186 0187	RO	Left coil voltage (mV)	69
0188 0189	RO	Right coil voltage (mV)	69
0190 0191	RO	Drive coil load (%)	69
0202 0203	RO	Internal temperature	70

* For Menu items refer to display menu structure in Figure 2.14 and menu items description in Table 2.7.

*** Reserved for future modifications.

APPENDIX E

Modbus register map version 3.xx (ProLink)

Modbus register map version V3.02

General information

The addresses in the tables below are decimal; the starting address is 1.

For example, address 127 corresponds to hexadecimal address 0x007EH (126 decimal).

Read/Write mode: WO – write only; RO – read only; RW – read and write

Coils

Functions: Read – 01, Write – 05

Read: 0 – Off ; 1 – On

Write: 0x0000 – Off , 0xFF00 – On

Address	Mode	Description	Menu item *
0002	RW	Start / Stop totalizers 0 – Stop totalizers 1 – Start totalizers	–
0003	RW	Reset totalizers (resettable) 0 – Abort 1 – Reset totalizers	18
0004	RW	Reset totalizers (inventory) ** 0 – Abort 1 – Reset totalizers	–
0005	RW	Zero calibration 0 – Abort 1 – Start zero calibration	16
0056	RW	Reset mass totalizer (resettable) 0 – Abort 1 – Reset mass totalizer	–
0057	RW	Reset volume totalizer (resettable) 0 – Abort 1 – Reset volume totalizer	–
0082	RW	Pressure compensation 0 – Off (default) 1 – On	39

* For Menu items refer to display menu structure in Figure 2.14 and menu items description in Table 2.7.

** To write in registers the switches 2-4-6-8 must be in ON position.

16-bit registers – integer values

2 bytes, high byte first

Functions: Read – 04, Write – 06

Address	Mode	Description	Menu item *
0003	WO	Register map version ** 1 – EMIS (default) 2 – ProLink	74
0016	RO	Transmitter software version - Format XXX.X	–
0039	RW	Mass flow rate unit 70 – g/s 73 – kg/s 74 – kg/min 77 – t/day 75 – kg/h (default) 78 – t/h	33

Address	Mode	Description	Menu item *
0040	RW	Density unit 91 – g/cm^3 (default) 96 – kg/L 92 – kg/m^3	36
0041	RW	Temperature unit 32 – °C (default) 33 – F	37
0042	RW	Volumetric flow rate unit 0 – mL/s 24 – L/s 17 – L/min 29 – m^3/day 138 – L/h (default) 19 – m^3/h	35
0044	RO	Pressure unit 0 – MPa 7 – Bar (default) 12 – kPa	–
0045	RW	Mass total unit 60 – g 61 – kg (default) 62 – t	32
0046	RW	Volume total unit 0 – mL 41 – L (default) 43 – m^3	34
0120	RO	Device type code 40 – Core Processor 21/41/42 – RFT9739/1700A/2700A	–
0125	RO	Alarms code	–
0126	RO	Alarms code	–
0136	RO	Zero calibration time (s)	–
0313	RW	Modbus slave address	28
0419	RO	Alarms code	–
0420	RO	Alarms code	–
0421	RO	Alarms code	–
0422	RO	Alarms code	–
0423	RO	Alarms code	–
0424	RO	Alarms code	–
0521	RW	Bytes sequence in floating point 32-bit registers 0 – 0-1-2-3 (default) 1 – 2-3-0-1 2 – 1-0-3-2 3 – 3-2-1-0	75
1138	RO	Output signals 0 – None 1 – Current + Pulse + RS485 (default) 2 – Fieldbus (H1) or Profibus-PA	–
1166	RO	Output channel A type 0 – Current (primary) (default) 1 – Pulse 2 – Digital 3 – Current (secondary) 4 – Discrete output 5 – Discrete input	–

Address	Mode	Description	Menu item *
1167	RO	Output channel B type 0 – Current (primary) (default) 1 – Pulse 2 – Digital 3 – Current (secondary) 4 – Discrete output 5 – Discrete input	–
1168	RO	Output channel C type 0 – Current (primary) (default) 1 – Pulse 2 – Digital 3 – Current (secondary) 4 – Discrete output 5 – Discrete input	–

* For Menu items refer to display menu structure in Figure 2.14 and menu items description in Table 2.7.

** To write in registers the switches 2-4-6-8 must be in ON position.

32-bit registers – single precision floating point values complied with IEEE 754 format

4 bytes, high bytes first

Functions: Read – 04, Write – 16

For example, value “-1.5” corresponds to “0xBF 0xC0 0x00 0x00” in the order from low to high address in memory.

Address	Mode	Description	Menu item *
0149 0150	RW	Low density cutoff (g/cm^3)	–
0155 0156	RW	Low density for density calibration (g/cm^3)	64
0157 0158	RW	High density for density calibration (g/cm^3)	62
0159 0160	RW	Period for low density (µs)	65
0161 0162	RW	Period for high density (µs)	63
0163 0164	RW	Temperature correction coefficient for density (% / 100ºC)	66
0189 0190	RW	Flow rate averaging time from 0.5 to 10 s in steps of 0.05 s	49
0191 0192	RW	Temperature averaging time (s) ***	–
0193 0194	RW	Density averaging time from 0.5 to 30 s in steps of 0.05 s	50
0195 0196	RW	Low mass flow cutoff (kg/h)	17
0197 0198	RW	Low volume flow cutoff (L/h)	75
0199 0200	RW	Upper limit of density range (g/cm^3)	58
0201 0203	RW	Lower limit of density range (g/cm^3)	59
0231 0232	RO	Zero point standard deviation (µs)	–
0233 0234	RO	Zero point (µs)	16
0247 0248	RO	Mass flow rate	1
0249 0250	RO	Density	3
0251 0252	RO	Temperature	3
0253 0254	RO	Volumetric flow rate	2
0257 0258	RO	Calculated pressure from external pressure sensor (kgf/cm^2) ***	73

Address	Mode	Description	Menu item *
0259 0260	RO	Mass totalizer (resettable)	1
0261 0262	RO	Volume totalizer (resettable)	2
0263 0264	RO	Mass totalizer (inventory)	21
0265 0266	RO	Volume totalizer (inventory)	22
0267 0268	RW	Coefficient of pressure compensation for flow (% / PSI)	40
0269 0270	RW	Coefficient of pressure compensation for density (% / PSI) ***	–
0271 0272	RW	Flow calibration pressure (kgf/cm^2)	73
0273 0274	RW	Pressure relating to 4 mA (kgf/cm^2) ***	42
0275 0276	RW	Pressure relating to 20 mA (kgf/cm^2) ***	43
0285 0286	RO	Measuring tubes oscillation frequency (Hz)	68
0287 0288	RO	Left coil voltage (mV)	69
0289 0290	RO	Right coil voltage (mV)	69
0291 0292	RO	Drive coil load (%)	69
0293 0294	RO	Live mass flow rate (zero point not counted) (kg/h)	–
0451 0452	RW	Input external pressure (kgf/cm^2)	41
		ASCII registers	
0072, 0073, 0074	RW	Calibration coefficient (g/s/µs) Format: XXXXXX Example: “23.350” , K=23.35 g/s/µs	40
0075, 0076	RW	Temperature correction coefficient for flow Kt (%/100ºC) Format: XXXX Example: “5.00” , Kt=5.0 %/100ºC	61

* For Menu items refer to display menu structure in Figure 2.14 and menu items description in Table 2.7.

*** Reserved for future modifications.